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and

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The Registered Office and Laboratories of the B.C.I.R.A. are :—
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Telephone : Central 1885. *Telegrams : CIRA*

The B.C.I.R.A. Scottish Laboratories are :—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone : 332

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The Foundry and the Iron and Steel Industry—II

Last week we dealt with a phase of the Report of the Import Duties Advisory Board, which related specifically to the foundry industry. Now it is proposed to review it in its broader aspects, because the report is one of the most remarkable documents issued in our time. The Committee says that the progress and organisation of the industry during the past five years—since our tariff policy was changed—have been on right lines, but adds that future expansion must be carefully planned under State supervision in the public interest. Comparing the comments with which this report has been received with those which would have been made even ten years ago provides an instructive example of a changed outlook, for a generation ago no industry was more essentially individual than this industry. The Committee suggests that the problem is to secure the systematic planning of the industry as a whole, and the maintenance and development of internal co-ordination and co-operation, with the aid of a tariff as far as necessary, and with the continuance of international agreements, while at the same time avoiding the evils of monopoly, safeguarding the public and fostering efficiency. New schemes for production originating outside the Federation should have the views of that body reported to an independent outside body. Price regulation is approved, subject to the general oversight of the independent body. It is said that there is a strong case for greater co-ordination of distribution at the producer's end, but that if merchants are efficiently organised, the industry should use their knowledge and experience. The reactions of increased mechanisation and fresh locations in industry should receive the attention of employers and employed to mitigate any hardships arising. These are the bare bones of this striking document, which has set forth an entirely new basis of relationship between this great industry and the State. It is bound to affect the great and closely related founding industry, because so much of that industry overlaps the iron and steel industry as normally understood, and inevitably the two will be judged by similar standards. We shall look with interest to the constitution of the independent body to which the industry is to look for the expression of the consumers' point of view. Two interests arise: That of the man in the street who becomes directly or indirectly a steel user because he owns a car, or uses a tram or train, or because he purchases domestic articles, and the business man who, not in the industry itself, buys from or sells to the industry.

Foundry Exports

It seems appropriate at this juncture to review briefly the progress registered in the export market by the United Kingdom foundry industry, as the half-yearly returns of the Board of Trade have just been published. A change of some importance has been made this year, as prior to 1937 apparently it was the custom of the department concerned to include radiator segments with cast-iron pipe up to 6-in. diameter. Despite this change, the export of such pipes has increased from 26,861 tons in 1936 to 30,208 tons in 1937, both figures, of course, referring to the past half-year. For the heavier pipes very little change is recorded. Real progress has been registered by the stove-grate section of the industry, and the tonnage exported has risen from 4,962 tons in 1936 to 5,924 tons this year. A similar condition has prevailed in the cast-iron cistern section, where a rise from 1,504 tons last year to 1,874 tons this year has been registered. A third classification, in which the foundry participates to a lesser degree, is that of "fencing material (other than wire)," and in this case something of the order of an eighty per cent. gain is shown. The earlier figures quoted are in general line with the whole industrial export position of the country in so far as manufactured goods are concerned. Whilst dealing with exports, it seems germane to include a few pertinent figures as to imports. Pig-iron imports, for instance, are rising, and during the first six months of the last three years the tonnages were: 46,259 tons in 1935, 65,568 tons in 1936, and 178,088 tons this year. Scrap, on the other hand, is of a decreasing quantity owing to the international scramble for supplies. It should be borne in mind that the economic structure of some countries is *force majeure*, based on scrap as their principal raw material. The importation of baths seems to us to be increasing unduly. After all, the weight of the metallic raw materials is relatively small, and constitutes no real menace to munitions production. Yet approximately 5,000 tons—probably 50,000 baths—have entered this country during the last six months, as against about 3,250 tons in 1935 and 1936 in the corresponding period. Finally, there are the imports of stove-grates, and here there is nothing to worry about, as there has been a progressive decrease in weight from 529 tons, and 344 tons, to 296 tons. As would be expected, the value this year is higher. Imported hollow-ware shows a slight gain in both price and quantity. In general, the situation is satisfactory, but still greater efforts must be made to increase foundry exports, especially as the home building trade is likely to suffer owing to the shortage of steel.

Abstracts of A.S.T.M. Committee Reports

MALLEABLE IRON CASTINGS (A-7)

Committee A-7 on Malleable Iron Castings of the American Society for Testing Materials has held one meeting during the past year. At this meeting a set of proposed by-laws was presented and adopted. An election of officers for the ensuing term of two years resulted in the selection of Mr. E. K. Smith, chairman; Mr. H. W. Faus, vice-chairman; and Mr. H. A. Schwartz, secretary.

Subsequent to the 1936 annual meeting, Committee A-7 presented to the Society through Committee E-10 on Standards, proposed Tentative Specifications for Cupola Malleable Iron (A 197 — 36 T) which had been prepared by Sub-Committee III on Cupola Malleable Iron (Mr. R. E. Bryant, chairman). The proposed tentative specifications were accepted by Committee E-10 on August 26, 1936. Sub-Committee I on Nomenclature and Definitions (Mr. H. A. Schwartz, chairman) has approved the definitions of "malleable cast iron" and "pearlitic malleable cast iron" which appear in the Tentative Definitions of Terms Relating to Cast Iron (A 196 — 36 T), prepared by Committee A-3 on Cast Iron.

At the meeting of the committee held on June 29, 1936, an interesting report on galvanising embrittlement was presented by Mr. Enrique Touceda, who at that time was chairman of Sub-Committee II on Galvanising Embrittlement. Sub-Committee VI on Pearlitic and Alloy Malleable Iron (Mr. H. M. Boylston, chairman) has under consideration the preparation of proposed specifications for pearlitic malleable iron. These proposed specifications have been discussed at the recent meeting of Committee A-7 which was held in New York City during the annual meeting of the Society.

CAST IRON (A-3)

Since the last annual meeting of the Society, Committee A-3 on Cast Iron has held two meetings. Subsequent to the 1936 annual meeting, Committee A-3 presented to the Society through Committee E-10 on Standards, proposed Tentative Definitions of Terms Relating to Cast Iron (A 196 — 36 T) which had been prepared by Sub-Committee X on Nomenclature and Definitions (Mr. Robert Job, chairman). The proposed tentative definitions were accepted by Committee E-10 on August 26, 1936. It is recommended that the present tentative standards under the jurisdiction of Committee A-3 be continued as tentative without revision.

Sub-Committee VI on General Castings (Mr. J. W. Bolton, chairman) has under consideration the establishment of deflection values in the flexure test for inclusion in the Standard Specifications for Grey-Iron Castings (A 48—36).

Sub-Committee XI on Methods of Testing (Mr. R. S. MacPherran, chairman) has been granted an appropriation of £40 by the Society's Committee E-9 on Research for research work on fatigue tests of cast iron being carried out by Mr. J. B. Kommers of the University of Wisconsin. The Sub-Committee will collaborate with Professor Kommers in this work.

Sub-Committee XV on Impact Testing (Dr. J. T. MacKenzie, chairman) has done sufficient work in impact testing to warrant making this information available to other members who are interested in conducting tests along the same lines. However, before doing so, a standard drop test machine must be adopted. The Sub-Committee is asking manufacturers of testing equipment for information regarding the quality of mechanical devices for this machine.

The Copper Outlook

BY "ONLOOKER."

Looking back over the first half of the year, one can see that copper has suffered many vicissitudes of fortune, the vagaries of the price movement alone being of an exceedingly startling kind. Held in the grip of the speculator, and believed by many to be likely to rise to £100 per ton, copper enjoyed a spell of notoriety which made it front page news for a period of weeks. In a sense it is still prominent in the public eye, but not on account of its high price, for the quotation has lately been well down in the fifties and the outlook is not particularly encouraging. The intriguing thing about copper just now is what the producers mean to do about reimposing restriction. The May figures suggested that the tide has turned, and that from now onwards one may expect to see, not only an increase in blister reserves, but also a growth of refined copper stocks. The industry can certainly do with rather more "background" in the shape of reserves than it has enjoyed of late, but the producers are not going to let the position get out of hand so that bears have a chance to launch an attack on a big scale.

Rising Costs of Production

Whatever may have been said in the past on the subject of what constitutes a fair price for copper, one must not forget that costs of production have risen and are still rising, so that if, for example, £45 was deemed reasonable eighteen months ago, £55 may represent the low limit to-day. It is not suggested that there is any immediate intention of a return to fettered output, for obviously stocks must be built up first, but it is just as well that all connected with copper should keep the possibility in mind, for that it will come one of these days is certain. One school of thought to-day maintains that consumption is increasing with sufficient rapidity to take care of the growth of output under the present go-as-you-please arrangement, but arguments under this head are rather lacking in conviction, and it is the writer's opinion that expansion on the usage side is likely to be gradual, if, indeed, there is to be any expansion at all. As a matter of fact, the outlook is not very promising on the Continent at the moment, and it does not seem as though 1937 will be a very remarkable year there as far as consumption of copper is concerned. France, as everyone knows, has her own peculiar difficulties, while the problem of financing imports has been vexing Germany for a long time past.

The standard market has practically freed itself from the incubus of the backwardation which for so many weeks this year has upset business in futures, but the increase in U.K. warehouse stocks which has proved instrumental in bringing about this improved state of affairs is now slowing down, and, as a matter of fact, quite a fair quantity of copper is being shipped away to the Continent. With the virtual disappearance of the backwardation, another abnormality has arisen to vex the trader who wishes to hedge his holding of copper; there is a very wide spread between standard and electro, the margin dividing the price of warrants from the official wire bar quotation being from £9 to £10. Is standard unduly cheap or must the price of electro come down into line with the quotation for warrants? For the present electro is scarce, and therefore the price will keep up, but it looks as if September will usher in a period of more plentiful supplies. This fact is likely to be reflected in a narrowing of the spread before then. Prophecy about price movements is notoriously dangerous, but the opinion is ventured that the price of standard copper will not fall below £50.

Random Shots

Some countries that could be mentioned, when they inaugurate a national campaign, decree that every man, woman, and child shall take part in it, and woe betide them if they don't do as they are told! In England the method is more subtle. Somebody gives a luncheon or a dinner to someone else and behold! the machinery of gentle persuasion is set into motion. Such a luncheon was given last week by George Cohen, Sons & Company, Limited, to help the Iron and Steel Federation in its "scrap" campaign. The setting was their Wood Lane scrapyard, the cocktail bar was rigged up in a wagon, the famous "600" was set up in ice at the entrance, and the guests were ushered into their places to the strains of the tune "Any Old Iron." The menu, printed on a perfectly good sample of scrap, was a masterpiece, and one that will be thoroughly appreciated by metallurgists the world over. It read as follows:—

Cantaloup Chêne Rond.

* * *

Saumon Maison à l'Acier.
Sauce Blooming.

* * *

Poularde Marchand de Ferrailles.
Jambon de Yorkshire.
Langue Douce.
Galantine Corporation.
Salade Mitraille.

* * *

Fonte Glacée.
Toles Fines.
Petits Fours Martin.

* * *

Café.

* * *

It is scarcely necessary, after perusing the menu, to add that Lord Dudley presided over the ceremony. Speeches, the general theme of which can be summed up as being eloquent appeals to the public to deliver up their old iron to the needs of industry, were made by Lord Dudley, Mr. I. F. L. Elliott, managing director of the British Iron and Steel Corporation; Mr. Ashley Ward, of T. W. Ward, Limited; Mr. Hale, President of the National Federation of Scrap Iron and Steel Merchants; Mr. Leighton Davies, chairman of the Raw Materials Committee; Mr. Lawrence Levy, chairman of George Cohen, Sons & Company; and Mr. V. C. Faulkner, Editor of THE FOUNDRY TRADE JOURNAL.

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It is to be hoped that, after having eaten such a magnificent "scrappy" lunch for the sake of their country, the public of Great Britain will not let them down. One good week-end spent in the attic, cellars and backyards should swell the industrial scrap heaps considerably. So, fellow citizens, get busy! Beware, however, of being carried away by the fervour of the moment and being too generous, like the woman who, on being spotted rummaging in the local scrap yard, called out, "Hi, Mister, give me back that pram I gave you yesterday. The doctor has been to see me and he says I'll need it!" (Lord Dudley's story).

* * *

This week brings news of two new uses for aluminium dust. One is that, if workers liable to silicosis inhale aluminium dust at the same time, the effects of the silica grains are counteracted. The other is that typewriter-ribbons are being impregnated with it, and the result, when used on dark paper, is said to be very attractive. Now if all the rules and regulations about silicosis were to be typed in aluminium and given to the workers to digest, would that not kill two birds with one stone? And, incidentally, would it not give much light on a very dark subject?

"MARKSMAN."

The Production of Ingot-Mould Castings

INTERESTING DISCUSSION IN DERBY

Introducing his Paper,* read before the Institute of British Foundrymen at their Annual Conference held in Derby from June 8 to 11, MR. R. BALLANTINE, the author, said it was open to discussion whether the lives of ingot mould castings were a true indication of quality. He felt it was an economic question, and bore upon production and relative costs. Mr. C. W. Bigg, in his address, used a phrase "systemisation of effort." He felt that was essential. Founding may be likened to a growing tree, ironfounding being the "trunk." "Branches" were "straggled" and numerous. Some showed the benefits of controlled development, whilst others were "gnarled" with old time "growths." A "grafting" of research and practice, coupled to mature experience and youthful enthusiasm, furthered the "tree" analogy by bearing "fruit." This was essentially a practical Paper, and he would like to appeal to the practical foundrymen present to ask questions.

Influence of Material Shortage

MR. J. ROXBURGH said that there was no doubt that the manufacture of ingot mould castings was a very important part of the industry. The development of ramming the cores in synthetic sand was one which has made the most outstandng contribution to the progress of this particular aspect of the industry. Mr. Ballantine made a remark that the lives obtained from an ingot mould were not altogether indicative of the quality of the casting. Unfortunately, that is the only method by which the quality of an ingot mould can be measured, and to-day, owing to the fact that it was not easy to get hold of hematite pig-iron, he believed the steelworks would extend the use of ingot moulds beyond the limit they were now doing. Also the question of the difficulty of obtaining supplies of hematite pig-iron might result in the specification for ingot moulds being slightly altered, and probably in the next twelve months it might be possible to collect some interesting data on the metallurgical side of ingot moulds. He believed that Mr. Ballantine has already obtained some interesting data on this matter, particularly in regard to manganese and silicon contents. Mr. Ballantine did not cast heads on his ingot mould castings. He contended that if the top surface of his casting were machined, in all probability, he would encounter defects, due to sand, blacking or "drawing." In Sheffield on these larger ingot moulds a point is made of incorporating a head on the castings, which is subsequently machined off, and in that way one saw that the top side was clean and sound, and in actual service that top side was brought to the bottom. The question of runners was also a very controversial one, and Mr. Ballantine had shown two types of runners; what he called the centrifugal ingates and the stepped ingates. On the larger moulds centrifugal ingates had always been used by the speaker with extremely good results. They were used so that a spin was imparted to the metal, and in the case of the larger moulds some of the ingates entered at a higher level to maintain the spinning action of the metal. He did not propose to enlarge on this subject, as he had prepared a Paper on the manufacture of larger ingot moulds, and had dealt with the matter on the practical and technical sides.

Runners and Feeders

MR. BALLANTINE said, as regards the question of runners, he could not but believe that with centrifugal ingates there was bound to be a scaling effect. The abrasive action was very severe, particularly with sluggish hematite irons. Moreover the points of attack, in octagonal and duodecagonal cores, were subject to an eddying effect due to core shape. It appeared very strange that hours and hours should be spent on feeding and putting heads on castings of this description.

MR. A. SUTCLIFFE pointed out that there were some thirty or forty heads cut from cylinders, callender bowls, and rams in his foundry at the moment, some of them weighing up to a ton. If any one of these heads were sectioned they would show holes inside, of serious dimensions. Surely this was preferable to having them in the actual casting, which would be the case if no head were used.

MR. BALLANTINE said he had examined thousands of ingot moulds, and he could not trace cavities due to lack of feeding.

MR. A. MARSHALL asked for more information about Fig. 13, in which were shown lifting irons for a 5-ton core.

MR. BALLANTINE: In reference to Fig. 13 and Fig. 20, there were no upright irons whatever. There were two lifters in Fig. 13, and three were used for balance in Fig. 20. There was a top covering on the irons which kept the lifters from responding to any movement, and furthermore, they would be cushioned with the ashes surrounding them.

Costs and Mould Life

MR. A. CAMPION said that he wished to congratulate Mr. Ballantine upon the Paper which he had presented. He thought that in the author they had an excellent example of the benefits to be derived from the introduction of new blood into a section of the foundry industry. Mr. Ballantine was a comparatively new entrant into the ingot mould business, having previously been engaged in the production of castings of a very different type. He had however set to work to study the possibilities of improving the technique of ingot-mould production and had been successful. It had for long been the custom to value a mould according to the life as represented by the number of heats, a method not altogether satisfactory and one which often led to a good deal of discussion between the steel maker and the foundry. So far as he could gather from the Paper, Mr. Ballantine's idea was to evaluate the mould from the angle of cost of moulds per ton of ingots produced. He considered that if the cost of production of the moulds could be sufficiently reduced a mould with a shorter life might be more economical than one with a longer life. Mr. Campion was inclined to think that Mr. Ballantine was correct in his contention and that he had gone a long way towards achieving his objective. Moulds did not always fail through cracking or crazing during use, many had their useful life reduced by mishandling and maltreatment in the works.

Mr. Ballantine had made what appeared to be somewhat disparaging remarks about what he calls metallurgical theorising and sand experimentation, but really the author, like so many others who claim as he does to be purely practical men, does not actually mean what the sentence appears to convey. It is merely a difference of language, because the author has in an earlier part of the Paper stressed and rightly stressed the importance of correct sand condition as regards permeability and bond strength. Sand control is a means of giving those properties a quantitative value, which is essential to the maintenance of constant condition of sand.

He thought that Mr. Ballantine had hit the right nail on the head when he stated that half the battle in ingot mould making is to obtain a suitable core centre so as to permit of relief when contraction of the casting occurs. He wished Mr. Ballantine success in the achievement of his ideal in the production of ingot moulds at an economic figure, and looked forward to reading more Papers from him.

MR. BALLANTINE, thanking Mr. Campion for his remarks, said that perhaps as a practical man he was falling into some of the failings of his research friends. Some of the sand tests in his previous Paper gave 126 as the number of permeability from A.F.A. apparatus.

MR. JONES said he noticed there were difficulties and troubles which were due largely to the foundry itself rather than the materials.

High-Phosphorus Content Moulds

MR. BALLANTINE said he had occasionally and unknowingly had a very high-phosphorus content iron and the moulds had given splendid lives in the steelworks.

Structural Changes

MR. J. HOGG said what was of interest to him and had caused him to think was that when the ingot mould was cast at the beginning he took it for granted that the metal in the casting had a normal form of carbon content. When the steel-maker had used the ingot mould and had sent it back to the foundry, had it been noticed whether the structure of the metal then compared with the original structure? It had occurred to him that the carbon would be higher and it would be interesting to know what Mr. Ballantine's thoughts were; whether he felt the iron had undergone a transformation and whether he thought it was possible to get it back to its former condition.

MR. BALLANTINE said he never used discarded ingot moulds, but relied upon the pure hematite. He had examined moulds which had reached lives well over 200 and they show a crocodile surface effect. The open matrix in the wall centre was due to the lack of feeding, and the benefits could be seen in the longer lives obtained. He could only speak of the premature failures and study in these, the probable causes of failures.

Influence of Composition

MR. N. L. EVANS said the firm with which he was connected used castings which were fired from the outside, and there had been a suspicion for some little time that a phosphorus content of about 0.3 per cent. was associated with an abnormally short life. Could Mr. Ballantine state the phosphorus content of the "high-phosphorus" ingot mould to which he made reference?

MR. BALLANTINE said he traced at one period two moulds with a phosphorus content of about 0.3 per cent. and found that the life in the steelworks was normal. A large factor in the ultimate life secured from these castings was undoubtedly steelworks usage.

MR. COOPER asked what would be the percentage of differentiation in the variation of casting temperatures? Also, was it customary to heat treat moulds before using them for the first time? When they had cases of 100 to 120 ingots per mould they made one envious. Had Mr. Ballantine found he obtained a skin on the metal? The metal which was mixed with high manganese iron very often gets a rough surface on the top during pouring which it was nearly impossible to get clear.

MR. BALLANTINE admitted that he did get these difficulties in casting. He was fortunate in so far as he supplied common moulds from stock and sent them to different steelworks. As already stated, in two steelworks average lives vary on

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* FOUNDRY TRADE JOURNAL, June 24, p. 530, July 1, p. 5, July 8, p. 32.

exactly similar moulds from 62 to 125. Steelworks usage was the greatest factor in mould lives.

Types of Failures

MR. J. BLAKISTON said there were two types of failures in ingot moulds. The first, cracking, which was peculiar to plate moulds, and the second, crazing, which afflicts regular shaped moulds. Many ingot mould foundries were attached to steel works and did not exist to make a profit, but solely to produce moulds as cheaply as possible. Therefore, it behoved the ingot mould manufacturer to concentrate on investigating his methods of production. The steel manufacturer generally used the scrapped moulds by melting in his own furnaces. The steel works, therefore, were only concerned with the production moulding cost of that mould, and really this was the sole charge to them, and this should be borne in mind when discussing ingot moulds.

A point that had been raised was the manganese content. Some personal practical experiments showed that up to 1.2 per cent. manganese a satisfactory life was obtained, and above 1.8 per cent. there was an improvement in the life.

He thought there were several iron and steel works in America now producing moulds from basic iron. He did not think phosphorus was such a vital matter to the lives of the moulds. He knew of moulds which have been sent out with phosphorus content as much as 1 per cent. and no complaint had been made.

As an ingot mould must have a perfect skin, he would like Mr. Ballantine's opinion on the method of mixing and of application of blacking. His experience of spraying blacking has not been satisfactory and he found it gave dummy scabs.

Blackings for Ingot Moulds

MR. BALLANTINE said good quality blacking was essential and nothing less than one sixteenth of an inch put on with a brush should be used. It should then be washed down with a camel hair brush and water. His foundry was never troubled with scabbing. The scabbing to which Mr. Blakiston referred was not due to the blacking but to the low permeability of the sand used. He was in a fortunate position in Scotland as the deposit of Scotch rotten rock sand seems eminently suitable for the manufacture of ingot moulds.

A MEMBER suggested that when one cast iron on to steel the steel would pick up carbon from the cast iron. Thus when steel was poured into an ingot mould was there transference of carbon from the skin?

MR. BALLANTINE said the question seemed to be one of equilibrium of heat in the mould and heat in the steel. The high temperature of the steel when pouring into the mould resulted in sudden shock to the mould casting, despite prior heating. So that it would appear non-feeding of castings has a definite advantage in as much that the open grained wall centre cushioned the initial shock and lessened the tendency to sudden splitting of the mould.

Long Life High-Phosphorus Moulds

MR. ROXBURGH, reverting to the subject of the phosphorus content, said that if one mixed, for the sake of argument, a percentage of common iron with hematite, it would mean it would still be necessary to incorporate in that mixture 80 per cent. of low phosphorus iron (to obtain a phosphorus content of 0.3 per cent. in the casting). From personal experience one of the best ingot moulds he had made was about 3 tons in weight, and it actually had about 340 lives with a content of 0.35 per cent. of phosphorus. He felt that, probably due to the shortage of hematite, some interesting results would be obtained.

MR. SUTCLIFFE said Dr. Tomlinson and himself had investigated heat resisting iron and had shown that it was neither a desirable nor necessary factor to have low phosphorus.

A vote of thanks was passed to Mr. Ballantine.

MR. C. W. BIGG, the chairman, apologised for having to leave the meeting, and his place was taken by Mr. F. J. Cook.

The Variations from the Users' Angle

MR. J. G. PEARCE wrote that anyone who had seen ingot moulds produced at the works with which the author was associated would appreciate the care and thought he had devoted to this matter and the excellence of the results obtained. From the point of view of mould production this and the previous Paper were of great value. The author rightly stressed the variations in life obtained on the same type of mould by different steel works, but it must not be forgotten that steel works also find variations in life in moulds from different foundries made to the same design and subjected, as far as possible, to the same conditions of use. When large quantities of moulds were used, the effect of day to day variations in steel works practice could be taken into account. There was, however, now a strong spirit of co-operation between makers and users of ingot moulds which offered the best possible augury of success in securing long-life moulds and better ingot surfaces, in support of which may be quoted the recent report, Section VI of the Seventh Report on the Heterogeneity of Steel Ingots, of the Ingot Mould Sub-Committee of the Iron and Steel Institute.

Problem of Wear Testing*

DERBY DISCUSSION ON MR. ELLIS' PAPER

Introducing his Paper, MR. OWEN W. ELLIS, said he wished to express his appreciation of the honour that was done him and his colleagues of the Ontario Research Foundation in choosing him to present the American Exchange Paper. One point of interest was that he happened to be an Englishman and have been chosen as a Canadian to present the American Foundrymen's Association Exchange Paper. There were two things which had pleased him very much in connection with his visit: one was the occasion of seeing Prof. Turner, his old professor, honoured by the Institute of British Foundrymen. (Hear, hear.) The second was his great pleasure, as one who served his time with the Great Western Railway, in coming to Derby, a railway centre of the first magnitude.

He then summarised his Paper.

Difficulties in Comparing Results

MR. PEARCE opened the discussion, and said he would like to say how warmly the Institute welcomed Mr. Ellis, for everybody remembered the work he did in this country, and followed with interest the work he was doing in the distinguished position he now held. He had had the pleasure of seeing the laboratories of the Ontario Research Foundation, and he thought he was right in saying that he gave the first public lecture in the new buildings there. Ontario had put up these buildings in much the same faith as the British showed in this country, and he looked upon this occasion with great pleasure as an opportunity of renewed contact with old friends. Wear results were usually based on a test approximating to service conditions, and it was thus difficult to compare the figures obtained by Mr. Ellis with those from other sources, because the conditions of the test were so different. Thus he found that a higher carbon in white irons lowered wear resistance, a conclusion contrary to that found under other conditions, although the conclusion respecting chromium would be generally accepted. The report, however, as a whole will be welcomed as a painstaking piece of work, which should interest those concerned with grinding problems.

Hardness and Wear Resistance

MR. F. J. COOK (Past-President) said the Paper was a very good basis for this very interesting problem. He would like to ask if Mr. Ellis had found that hardness was of itself a reliable guide as to the wearing qualities of the metal, and had he found that some of the softer alloys improved by wear hardening?

MR. ELLIS, in reply, said that the most recent work tended to show that in this particular type of abrasion, hardening or wear hardening scarcely entered into it. It might be, of course, in larger mills where balls were falling through greater distances. He had turned his attention to the effect of atmospheres particularly, in small porcelain jars.

Rubber as Wear Preventive

MR. MILLINGTON said that whilst it was not his intention to refer to the metals used in this research, on which the author was to be congratulated, he would, however, like to refer to an experiment in which an attempt to solve the wear taking place on the hammers of a coal pulverising machine was made. Various alloys were tried without any marked success. Noting the high resistance to wear of the modern motor tyre, it was thought that hammers coated with rubber might solve the problem. After discussing the proposal with the rubber experts, hammers were "sleeved," but it was found that a few hours' work wore the rubber away, and the experiment failed. He wondered if the author had tried rubber, and, if so, with what results.

MR. ELLIS said the mill referred to was lined with rubber and stood up very well and looked as if it were going to last for a number of years without wearing through. A number of mills in North Canada had been lined with rubber. The difficulty had been binding the rubber to the mill. He thought there was a likelihood that in mills rubber might come into its own when methods of applying the rubber to the steel have been discovered.

MR. J. H. COOPER said one thing which interested him was the reference to manganese steel. He found in making this steel that the best results were given with about 12½ to 14 per cent.

MR. ELLIS said he chose 14 per cent. as the desirable figure. He thought that the nature of the atmosphere in the testing apparatus was of very great importance.

Martensitic Materials for Wear Resistance

DR. A. B. EVEREST, after expressing appreciation of the Paper, stated that Mr. Ellis was carrying out wear tests under ideal conditions. In ball mills, the life in service was generally so short that tests could be carried out on different materials under actual service conditions or under conditions closely related to them, and the results of such tests could usually be given an immediate interpretation. The trouble with most wear testing, as for example in the automobile industry, was that in order to obtain results the rate of wear must be accelerated generally by having insufficient lubrication. Under such conditions a quick result could be obtained, but it was often difficult to interpret this result in terms of life in service.

Dr. Everest thought one of the most important points arising from the present Paper was that there did not seem to be a definite relationship between hardness and wearing quality

* Discussion on a Paper, "Wear Tests on Ferrous Alloys," read before the Annual Conference of the Institute of British Foundrymen, held in Derby from June 8 to 11, and published in the FOUNDRY TRADE JOURNAL, July 8, p. 23.

even under conditions where apparently the wear was purely abrasive, and this emphasised once again the fact that resistance to wear is determined by many factors, amongst which, besides hardness, were toughness, corrosion resistance, heat resistance, and so on. In some of the results shown by the author it would appear that the wear occurring in ball mills showed frequently no relationship to hardness, and undoubtedly toughness was frequently of more importance than hardness in this respect. This fact was brought out in a particularly interesting manner when studying some of the harder martensitic types of cast iron. In this connection some very interesting results have recently been obtained from irons in which the martensitic structure was associated with small quantities of austenite. Such irons were produced, for example, by the addition of about 7 per cent. of nickel, and had given extraordinarily good results. In the case of a pump handling coal washing slurry, in which ordinary steel impellers were lasting only one day, special steels and white cast iron were giving four or five days, whilst the alloy cast iron with the mixed austenite-martensite structure gave some four or five weeks. In such irons there was undoubtedly available improved toughness and corrosion resistance, both of which have undoubtedly an important effect in resisting the corrosion and erosion likely to take place under these working conditions.

MR. ELLIS said that he had had sections of liners from ball mills to examine, and the impression gained was that the amount of wear hardening was very small indeed. Users of ball mills seemed to think it was converted to a martensitic structure.

Austenitic Cast Iron Drilling Machinery

MR. FRANK HUDSON said he had been privileged to complete a research into the production of valve materials suitable for use in oilfields for handling drilling mud. In drilling an oil well, mud was forced down the bore to bring up the detrital matter cut away by the drill, and to do this very high pressures were needed, often exceeding 1,000 lbs. per sq. in. It could be readily appreciated that the equipment on this service wears out rapidly and entails high maintenance charges. At the present time the United States probably holds a monopoly in the supply of such equipment, and he was asked if it were not possible to develop improved plant for this service. He set out to conduct wear tests on various metals by mounting specimens on a disc, not unlike the impellor of a centrifugal pump, and rotating this through the mud laden mixtures, and it was perhaps interesting to record that the results obtained tended to follow those given by Mr. Ellis in his Paper. For example, a specimen of nitrogen hardened steel having a hardness of over 900 Brinell, after running 200 hours, showed a wear loss of 84.4 grms. per sq. metre per 24 hrs., whilst austenitic cast iron having a hardness of only 166 under identical conditions only wore at the rate of 16.4 grms. per sq. metre per 24 hrs. Even gunmetals with a Brinell hardness of around 70 gave better results so far as wear was concerned than many of the hardened steels. A whole series of tests embracing over 40 ferrous and and non-ferrous metals clearly indicates that wear in the presence of a corroding agent in many cases is not determined by hardness, but appears to be essentially connected with the corrosion resisting properties of the metal.

Corrosion Fatigue

MR. ELLIS said he had been wondering whether in some of his tests there was not the question of corrosion fatigue. He believed corrosion fatigue merely meant that the material was going to lose weight more rapidly. He thought that in ball mills corrosion fatigue did play a part, and the stresses must be very high during the life of the ball in the mill.

Hardness and Machinability

A MEMBER said the discussion had raised two points upon which he had done work. Using Brinell hardness in relation to wear was one thing, but in his opinion it had no relation to machinability. At one end only of the scale of Brinell hardness one obtained remarkably good wear and machinability. From a machining point of view, he felt Brinell hardness was likely to be more misleading than helpful.

MR. ELLIS, agreeing with what the speaker had said in regard to machinability, said he had always insisted when discussing this point that Brinell hardness numbers were no criterion of machinability.

Vote of Thanks

THE CHAIRMAN tendered to Mr. Ellis the thanks of the Institute for the preparation of the Paper, and MR. P. A. RUSSELL, seconding, said that he had read the Paper with very great interest. It was rare to have exchange Papers presented in person, and he was particularly glad to welcome Mr. Ellis.

MR. ELLIS, in acknowledging, said he much appreciated the hospitality shown him at this meeting. He had enjoyed every minute of it.

MR. DELPORT said that in connection with the Paper from Mr. Ellis, and the exceptional pleasure everybody had had from it, he would like to announce that he had just received a cable from the American Foundrymen's Association in which the Board of Directors send their greetings and best wishes for the success of this Conference.

MR. T. MAKEMSON said that the Institute had also received greetings from the French Foundry Association which read: "We send our British colleagues cordial salutations and best wishes for the Conference." Greetings have also been received from several Institute members, including Mr. A. Harley, Past-President, who has been seriously ill.

The Foundry School

MR. PEARCE then made a statement as to the position of the British Foundry School. This was printed on page 45 of the JOURNAL last week.

MR. C. C. BOOTH, commenting on this, said that whilst he had been listening to the President's brilliant address, he felt that the members of the foundry industry might be charged with gross neglect. All yesterday's speakers emphasised the necessity for educating the younger members of the industry, yet this was a point which had been for many years sadly neglected.

Two years ago the British Cast Iron Research Association and the Institute of British Foundrymen, in collaboration with a number of other technical associations, started a Foundry School. It had been said that it was unfortunate that this should have been done so soon after the inauguration of another excellent course at Sheffield University, but he did not think that there was any real clash between the two. The course given by the Foundry School was a curtailed one, and it was essentially for men with some previous foundry experience.

He would like to emphasise the excellence of the training given. He showed the examination Papers to the Principal of a large London technical institute, and he commented that anyone, who could answer it well, as all those who had taken the course did, would have a mass of very valuable knowledge.

Continuing, he said from the report circulated it will be seen that there were 13 students for the first year, but now the second year only five. Although the educational authorities, it is thought, are not likely to withdraw the very substantial grant which they make towards the upkeep of the School, and it amounts to nearly three-quarters of the total, as taxpayers foundrymen would not wish their money to be spent on an object which was receiving so little support from the industry which it was planned to assist.

It is for the members of the Institute to follow the President's lead, and assist this cause as much as possible with men even more than with money, and thereby to assure that the young men in the industry were given a suitable training. If one firm alone was not able to send a student, it might be possible to send one from, say, three or four. It might even be possible for each Branch to arrange for one or two students to be sent by its members. He sincerely hoped that this excellent project was not going to be allowed to drop from lack of interest after the valuable lead given by the President.

Oxygen in Steel

The Seventh Report on the Heterogeneity of Steel Ingots (Iron and Steel Institute *Special Report No.* 16) recently published contains the first report of the Oxygen Sub-Committee. We append the following summary.

The report represents the co-ordinated work carried out at the National Physical Laboratory, Sheffield University, the Central Research Department of the United Steel Companies, Limited, and (from October, 1936) the Research Department of Imperial Chemical Industries (Alkali), Limited.

The Vacuum Fusion Method.—Three laboratories describe in complete detail the equipment and method of operation of the apparatus for the determination of the total oxygen by the vacuum fusion method. There are essential differences in the various sets of apparatus, but it is gratifying to note that substantial agreement is now reached between the co-operating laboratories.

The Alcoholic Iodine Method for the Separation of Oxides in Steel.—The joint contribution by the respective chemists describes the method of separating oxides in steel, and some data follow, in which the effect of stirring with the application of external heat and the effect of a prolonged time of churning is given. Another section describes in detail the methods used for the analysis of the non-metallic residues obtained by the iodine method, and it was further thought necessary to set out in detail the method adopted for reporting the results obtained, with an explanation of how the various figures as reported are arrived at.

The Chlorine Method.—The chlorine method practised in one laboratory is similarly described in detail, and then follows a statement of the results obtained on a few samples of steel in four laboratories, using the vacuum fusion, the iodine extraction and the chlorine extraction methods, respectively.

The report concludes with a commentary on the advantages and limitations of the methods described and on the results obtained. The Sub-Committee proposes to continue this work with particular reference to the improvement of the vacuum-fusion method in the direction of evolving cheaper types of equipment, and to the possibilities of fractional evacuation for the determination of the oxygen fraction occurring in the different oxides. Further, it is fully recognised by the Sub-Committee that the iodine-extraction method has definite limitations, and work is continuing on the influence of various elements and the interference with the determination of oxides by this method. Similarly, the chlorine method is being studied with particular reference to the relative merits of the chlorine and iodine methods, in particular for steels in which special elements occur. Notwithstanding these limitations, it is felt that sufficient progress has been made to undertake with reasonable satisfaction the determination of oxygen in further series of samples of steel.

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Gear Castings with Special Reference to Cast Iron*

By OLIVER SMALLEY

The selection of any gear material depends upon both the service conditions and the limitations imposed by manufacturing methods. A cast gear effecting manufacturing economies would seem to place savings as the first consideration and might imply limitations of service to those parts where stresses are necessarily low and operating conditions relatively unimportant. Despite this, cast gears find an important place in industry and one which in recent years has increased steadily due to the advancing knowledge of metallurgy and the improvement in the art of foundry practice.

Of the materials used for the manufacture of cast gears, possibly cast iron, because of its low cost and easy casting properties, still takes the lead. Due to its inherent low strength, brittleness and openness of grain under mass influence, it is still regarded not only with great distrust, however, but as a material of unreliable engineering properties. No doubt past experience with cast-iron gears justify such a decision, but this "oldest of ferrous metals" has seen greater progress metallurgically during the past fifteen years than any other metal, and whilst much of this advancement may not yet be available to the engineer in a cut and dried form, nevertheless, it has been both substantial and real. Today, cast iron offers for many types of gears properties that not only compare with the so-called superior metals—steel and bronze—but advantageous properties that are peculiar to itself.

Progress of Cast Iron

Briefly, the progress of all methods of improvement of the so-called modern cast irons may be said to have been concentrated in the control of both the quantity and form of the graphite in a matrix of some predetermined physical constitution. Many methods have been developed to accomplish this, such as:—(1) Melting with low total carbon in the electric furnace; (2) addition of special alloys; (3) pouring borderline irons in hot moulds, and (4) using special methods of casting, followed by a complex annealing process and heat-treatment.

For the purposes of this Paper, remarks will be confined to the well-known Meehanite process which is now employed by foundries in the principal countries of the world and registered under the name of Meehanite metal.

The essential difference between Meehanite metal and cast iron is that the latter embraces a family of materials of uncertain physical constitution within its scope, whereas Meehanite metal is a material of definite physical constitution and engineering properties. It differs from the common variety of grey cast iron in that it has no undesirable constituents, and the physical constitution of the matrix and the quantity and form of the graphite are under positive and accurate control. The nature and the physical properties of the essential constituents of cast iron are given in Table I.

Hence, from the many possible combinations of these varied and different constituents it will be seen that cast iron may be anything from a weak friable material of the softness of copper to one that is strong, tough and comparable in properties to tool steel, according to which of these constituents predominate and their structural relation one to another. This is displayed by photomicrographs shown in Figs. 1 to 6, taken from six different cast irons, the properties of which are set out in Table II.

From Table II it will be seen that a series of gears each made in one of these cast irons will behave very differently in service. It is also obvious that whilst a tensile strength of 11.5 tons per sq. in. may be common to any ordinary cast iron, if it were made so that the matrix were wholly pearlitic and if the graphite were distributed in a completely harmless form, it could have a tensile strength of 67 tons per sq. in. Unfortunately the presence of mechanically deposited graphite, even if in nodular form, does break up the continuity of the matrix; but obviously the weakening effect of the graphite shown in Fig. 6 is considerably less than that

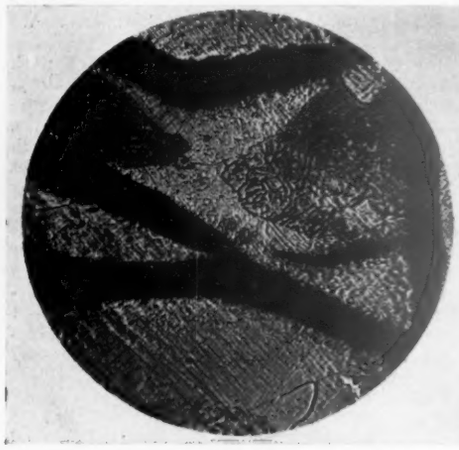

FIG. 1.—COMMON GREY IRON.

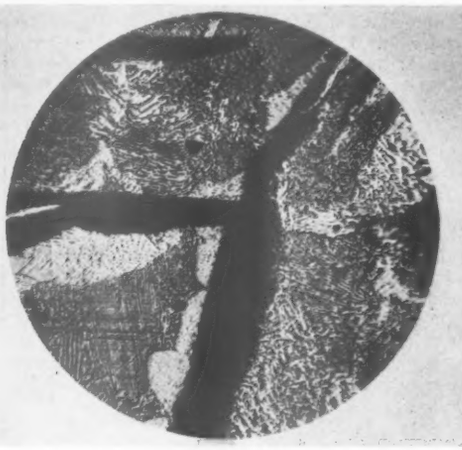

FIG. 2.—STEEL MIX IRON.

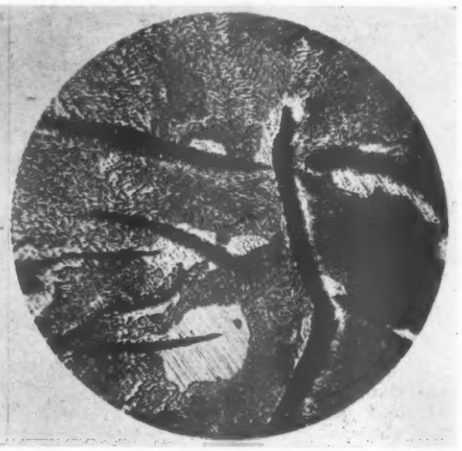

FIG. 3.—ALLOY CAST IRON.

FIG. 4.—MEEHANITE C.

FIG. 5.—MEEHANITE B.

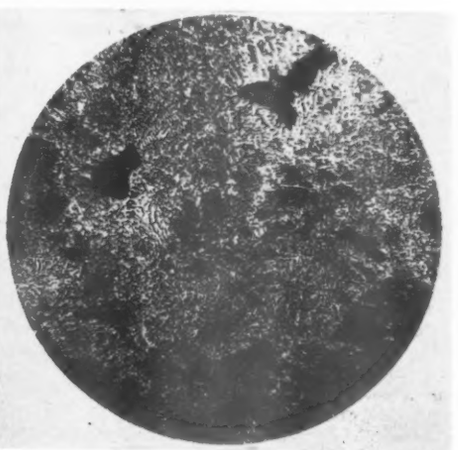

FIG. 6.—MEEHANITE A.

Photomicrographs Figs. 1-6 are × 1,000, but have been reduced to ⅔ diameter on reproduction.

* A Paper read before the American Gear Manufacturers' Association.

in Fig. 2, which has a tensile strength of only 11.5 tons per sq. in. On the other hand, with the combination of constituents as shown in Fig. 6, which in the finished casting gave a tensile strength of 28 tons per sq. in., there is combined

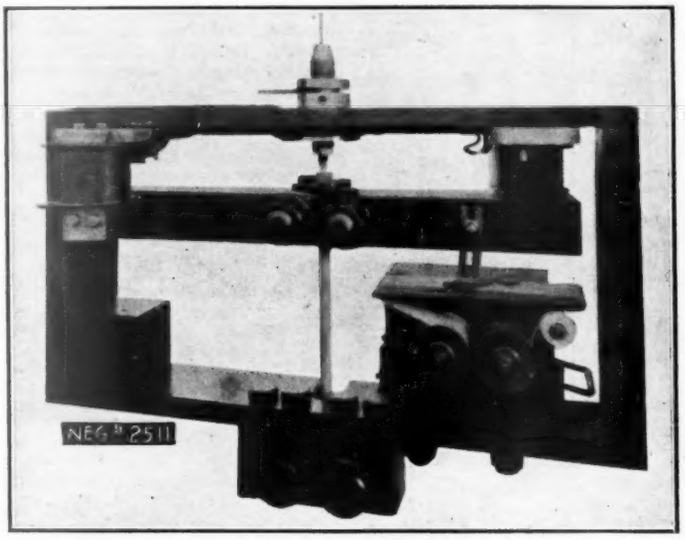

FIG. 7.—FOEPPL-PERTS TESTING MACHINE.

both the strength properties of steel with the distinguishing characteristics of cast iron.

Fatigue

Possibly one of the main objections to Meehanite metal or cast iron for gears is its low ductility value as compared with other metals. Recent developments in the testing of metals, by McAdams, Moore and Kommers have shown, however, that resistance to distortion and fracture is by no means a simple property and that the usual ductility tests as measured by the tensile test-bar will by no means predict how a material will resist dynamic stresses of the order or nature as encountered by gears in service.

One of the interesting out-growths of these investigations is the fact that the grey cast iron family of metals showed a proportional resistance which compared favourably with steel. Some typical figures are given in Table III.

There are two reasons for the favourable showing of both Meehanite and cast iron:—(1) They have the property known as crackless plasticity, a property of cast iron enabling it to withstand an occasional over-stress without the development of a fatigue crack, and (2) they have a high damping capacity for vibration which prevents reasonance stresses building up to dangerous proportions; in other words, the internal friction of the material converts the energy of vibration into heat and disperses it.

To understand this principle of damping vibration, consider what would happen if a tuning fork were made of cast iron or Meehanite. When struck it would vibrate for a few seconds only. A fork made of steel would vibrate five to eight times as long and one of aluminium twelve times as long—giving forth a continuous sound wave.

To measure this the Foeppl-Perts machine—Fig. 7—is used. This machine adopts the same principle as the vibrating tuning fork, except that the test-bar is a round shaft which is given a torsional twist and is released suddenly and allowed to vibrate back and forth in its natural frequency until all energy is absorbed or damped and the bar becomes stationary. The lower end of the test-bar is clamped to the iron frame—Fig. 7—while the upper end engages a heavy cross piece which is free to vibrate back and forth transmitting the vibration to a pen which records it on a travelling strip of paper to the right. The whole apparatus is suspended by means of a wire from the ceiling, so that the test may be isolated from all extraneous disturbance.

The dimensions of the test-bar used are:—Length under strain, 7⅞ in.; diameter, 0.475 in.; and distance between the axis of the test-bar and the point of the stylograph, 6 in.

A record of the tests made on Meehanite, grey cast iron and steel are shown in Fig. 8. Fig. 9 shows the relative specific damping capacity curves of common cast iron and semi-steel, and Fig. 10 shows relative damping capacity of process E Meehanite, process G A Meehanite and bar steel of 0.23 per cent. carbon. It will be observed that the steeper the curves rise, the more efficient is the material in absorbing vibration. The most efficient of all materials is common grey iron, such as is shown in Fig. 2, but it will be noted that its useful stress range is exceedingly low because of its poor strength value. Fig. 10 shows that as the tensile properties increase, the efficiency to absorb vibration decreases, although the damping capacity of G A Meehanite, 25.5 tons tensile, is

TABLE II.—*Properties of Irons shown in Figs. 1 to 6.*

Micro. No.	Types of iron.	Tensile strength. Tons per sq. in.	Brinell hardness. No.
1	Common grey iron from large gear	6	141
2	Semi steel	11.5	178
3	Alloy cast iron.. ..	15	207
4	Process C Meehanite cut from large gear..	19	207
5	Process B Meehanite ..	26.5	212
6	Process A Meehanite ..	28	217

TABLE I.—*Physical Properties of the Essential Constituents of Cast Iron.*

Constituent.	Physical condition in casting.	Specific gravity.	Tensile strength. Tons per sq. in.	Elongation. Per cent.	Brinell.
Ferrite (Fe) ..	Iron containing iron silicide in solid solution	7.86	23	40	95
Pearlite ($Fe_{21}Fe_3C$)	A fine laminated structure of cementite and ferrite	7.846	53	20	197
Sorbite ($Fe_{21}Fe_3C$)..	A very fine granular structure of cementite and ferrite	7.846	71	15	255
Cementite (Fe_3C) ..	A compound of iron and carbon containing 6.67 per cent. carbon	7.66	2.4	None	550
Phosphide (Fe_3P) ..	Phosphide of iron (Fe_3P) and phosphide of iron dissolved in iron	7.32	None	Brittle	400
Graphite	Carbon	2.55	None	Non-coherent	None

By volume, these may be present in quantities—
Up to 92 per cent. ferrite.
,, 92 per cent. pearlite.
,, 92 per cent. sorbite.
,, 43 per cent. cementite.
,, 15 per cent. phosphide.
,, 12 per cent. graphite.

TABLE III.—*Fatigue Tests on Various Materials.*

	Endurance limit. Tons per sq. in.	Endurance limit. Per cent. of tensile strength.
Ordinary cast iron ..	4.02—5.35	43
Special cast iron ..	8.02	44
GA Meehanite ..	10.27	45
GM Meehanite ..	12.23	46
Steel castings	13.38	46
Welded structure ..	5.35	30

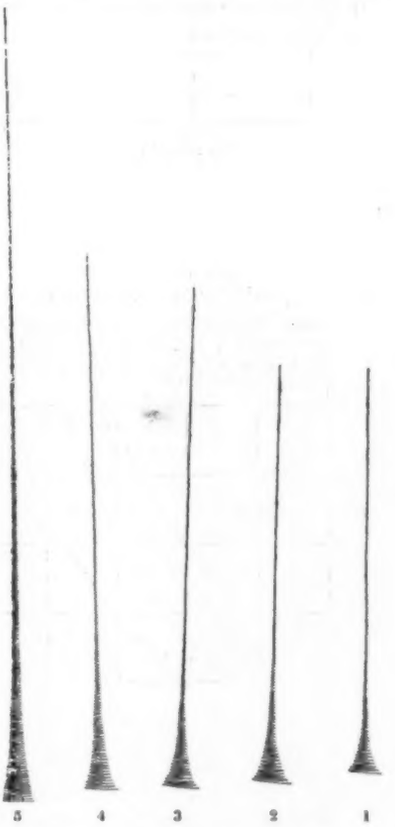

FIG. 8.—RECORDS OF VIBRATIONS OF VARIOUS IRONS IN A FOEPPL-PERTS TESTING MACHINE.

superior to that of semi-steel of 13.5 tons tensile. The semi-steel, however, is vastly superior to bar steel.

To use these curves, it is best to select the stress to which a member is liable in service on

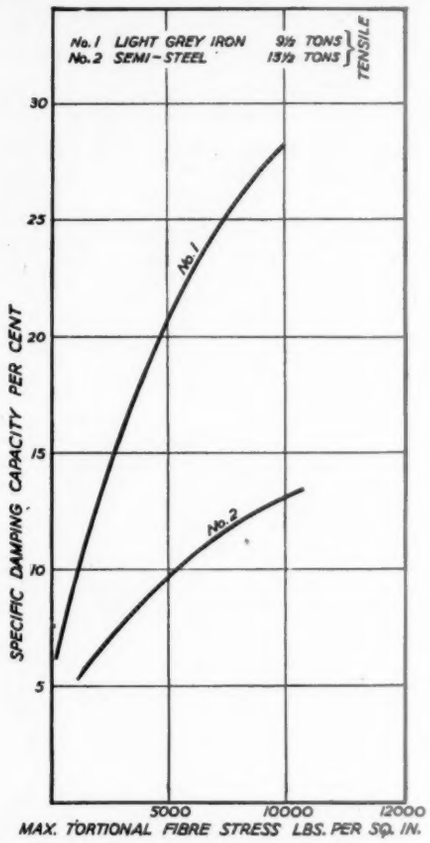
No. 1 LIGHT GREY IRON 9½ TONS
No. 2 SEMI-STEEL 13½ TONS
TENSILE
SPECIFIC DAMPING CAPACITY PER CENT
MAX. TORTIONAL FIBRE STRESS LBS. PER SQ. IN.
No. 1
No. 2

FIG. 9.—SPECIFIC DAMPING CAPACITY OF CAST IRON AND STEEL MIX IRON.

the horizontal axis, and the percentage of energy absorbed in the first cycle of free vibration will be found on the corresponding vertical axis. In these particular tests the first complete cycle

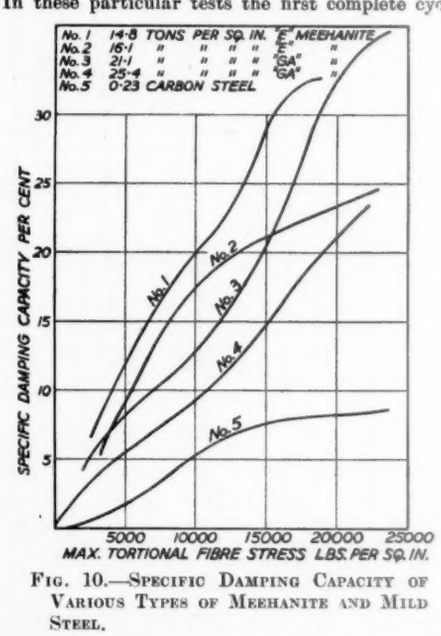
No. 1 14·8 TONS PER SQ. IN. "E" MEEHANITE
No. 2 18·1 " " " "E" "
No. 3 21·1 " " " "GA" "
No. 4 25·4 " " " "GA" "
No. 5 0·23 CARBON STEEL
SPECIFIC DAMPING CAPACITY PER CENT
MAX. TORTIONAL FIBRE STRESS LBS. PER SQ. IN.
No. 1
No. 2
No. 3
No. 4
No. 5

FIG. 10.—SPECIFIC DAMPING CAPACITY OF VARIOUS TYPES OF MEEHANITE AND MILD STEEL.

of free vibration was made in about one-seventh of a second.

Table IV indicates the extent to which energy is absorbed from a 8.8 tons per sq. in. torsional stress.

Expressed simply they show that by proper distribution of the graphite in a pearlitic matrix, Meehanite metal is able to maintain the high damping characteristics of grey cast iron in conjunction with the strength properties of a steel casting. The value of this combination to a gear where noiseless and smooth operation is required is obvious.

Repeated Shock

Shock strength is not ordinarily looked for in cast iron. Under repeated shock where the stresses are reasonably within strength requirements, however, this material may show surprising results. Its superior damping characteristics is its first line of defence—as has already been discussed. The second contributing factor is a function of the ability of the matrix to resist the progressive penetration of cracks. This is the property of crackless plasticity—which Professor H. F. Moore has described in his Papers on grey cast iron.

Unfortunately, there is little real information on the alternating impact properties of various cast irons, and there is no correlation of other properties to this one. In a general way, a high tensile strength is more desirable than a low one, but the rule is not an invariable one. Minimum breaking strengths and deflections on the transverse bar and Talbott strip have been used for many years by the pipe engineers as a protection against brittleness, but this has not been found to be of the same value to the higher strength cast irons.

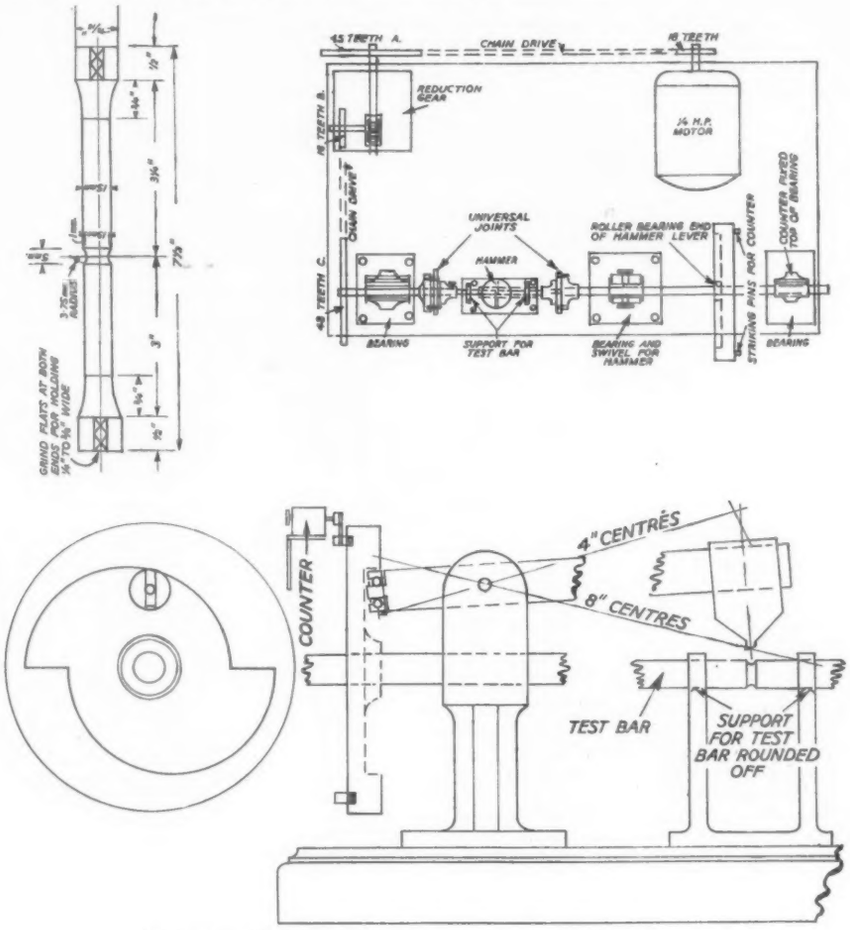

FIG. 11.—IMPACT TESTING MACHINE AND TEST-BAR USED.

From the metallurgist's point of view, toughness is associated with a full pearlitic matrix free from brittle constituents such as the phosphide eutectic and cementite, etc., and in this regard Meehanite is an ideal material as shown by Fig. 6.

By the use of the machine shown in Fig 11 a series of alternating impact tests have been made.

This machine is basically similar to the Stanton Repeated Impact Machine. The test-bar, shown in Fig. 11, is revolved at a speed of 40 revs. per min., by an electric motor driving through a reduction gear. The bar is supported on knife edges, 100 mm. apart, and a hammer blow is delivered at the centre of each half revolution. The actual drive is by means of flexible couplings so that the full force of the blow is taken on the bar and knife edge alone. A blow of 1 ft.-lb. is obtained by means of a 4-lb. hammer falling through 3 in., operated by a cam in a flywheel which is driven through the medium of the test-bar itself. This arrangement was adopted as providing the simplest form of

TABLE IV.—*Relative Energy Dissipation.*

Energy dissipated at end of	Steel 0.23 per cent. C. Per cent.	Semi-steel. Per cent.	Process E Meehanite 14.7 tons tensile. Per cent.	Process GB Meehanite 21.4 tons per sq. in. tensile. Per cent.	Process GA Meehanite 25.4 tons per sq. in. tensile. Per cent.
1st cycle	9	24	32	36	24
10th cycle	50	89	92	85	85
20th cycle	75	97	99	93	95

cut-out when the test-bar fractured, and a revolution counter is operated by the flywheel. It has been found that it is truly a measure of structural weakness, revealing quickly the presence of any constituent that is likely to cause brittleness.

A cast iron containing excessively coarse and interlocking graphite, such as is shown in Fig. 2, broke after fifty-one blows. The ideal graphite would, of course, be the nodular form as disclosed in Fig. 6 in a sorbo-pearlitic matrix; although a high value is obtained when the matrix is all pearlitic and the graphite is distributed evenly in the form of small minute flakes (Fig. 4). Average results from this machine are set out in Table V.

TABLE V.—*Strength as Revealed Under Repeated Impact.*

		No. of blows.
Coarse grey cast iron	Fig. 1	50
Semi-steel	,, 2	100
Alloy cast iron	,, 3	500
Process C Meehanite	,, 4	3,000
Process B Meehanite	,, 5	8,000
Process A Meehanite	,, 6	12,000

While these results (Table V) are subject to some variation, they do indicate that Meehanite is free from the brittleness of ordinary cast iron and despite the fact that the tensile tests show a low elongation percentage value, it is capable of absorbing considerable shock, quite comparable to cast steel.

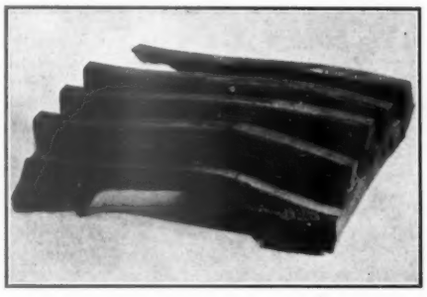

FIG. 12.—PIECE FROM MEEHANITE A BULL GEAR.

Fig. 12 shows a piece broken out of a 126 2 D.P. Process "A" Meehanite bull gear, with cut spur teeth. Fracture was obtained by dropping under a 7,500-lb. drop ball from a height of 26 ft. This amply illustrates the toughness feature.

(To be concluded.)

Catalogue Received

Dust and Fume Collection. A very interesting and intelligently-compiled brochure has just been issued by the International Corporation, Limited, 19, Ebury Street, London, S.W.1, which describes and illustrates the Traughber Froth Flotation method of cleaning and purifying air and gases and of extracting and collecting the dust and impurities. The system is based on the passage of the dusty atmosphere or gas through a mist or froth. The mist is formed by allowing a smooth cylinder rapidly to rotate on the surface of a washing bath, upon which a few drops of oil are allowed to drip at intervals. Froth is formed by making the air or gas to bubble through a layer of washing liquid upon which drops of special oil are allowed to fall at a predetermined rate. The system is especially suited for vitreous enamelling shops, and judging by the list of installations made the system is particularly popular with foundry concerns. We suggest that it is well worth while for foundry executives to familiarise themselves with this system.

Canadian Iron Foundry Industry

A special study of all reports submitted to the Canadian Bureau of Statistics indicates that in 1935 there were 330 operating iron foundries distributed across Canada as follows:—Ontario, 176; Quebec, 69; British Columbia, 33; Manitoba, 11; Nova Scotia, 15; Alberta, 10; Saskatchewan, 4; New Brunswick, 10; Prince Edward Island, 2. These foundries used 115,633 long tons of pig-iron, 196,747 short tons of scrap iron and 73,166 short tons of foundry coke during 1935.

The total production from these works was valued at $82,258,156 in 1935, but, of course, only a part of this total was made up of iron castings or cast iron products. Machinery, farm implements, locomotives, stoves, boilers, engines, and a variety of other products were made by these concerns which operated foundries in connection with their business. The value of custom or "commercial" castings reported under the headings of "grey iron castings" or "malleable iron castings" amounted to only $9,486,040; other castings are reported under specific items such as "cast-iron pipe," "machinery parts," etc.

The table gives summary statistics for the firms which operated iron foundries in 1935. The figures, of course, cover the entire manufacturing operations of these 340 establishments, and it is not possible from the information at hand to determine the proportions which apply to the foundry divisions only. Data under the heading "commercial iron foundries" are for the foundries which reported a production for sale under the general headings of "grey iron castings" and "malleable iron castings," and figures under the heading "other iron foundries" are for foundries which reported under specific items such as stoves, pipe, machinery, farm implements, etc.

Principal Statistics for All Iron Foundries, 1935.

	Commercial iron foundries.	Other iron foundries.	Total all iron foundries.
Number of foundries	209	121	330
Capital employed .. .. $	53,886,441	135,464,330	189,350,771
Number of employees	11,583	20,069	31,652
Salaries and wages .. .. $	11,754,671	21,602,518	33,357,189
Cost of materials at works .. .. $	10,748,876	21,432,368	32,181,244
Selling value of products at works .. .. $	30,318,856	51,939,300	82,258,156
Iron castings made for sale .. .. short tons	106,398	—	106,398
$	9,486,040	—	9,486,040
Pig-iron used .. .. long tons	70,873	44,760	115,633
$	1,524,803	931,811	2,456,614
Scrap iron and steel used .. .. short tons	112,335	84,412	196,747
$	1,183,799	955,572	2,139,371
Foundry coke used .. .. short tons	45,307	27,859	73,166
$	486,874	312,737	799,611

(Concluded from next column.)

Approximately £680,000 of the research expenditures of the industry this year will go to discovering means of improving the quality of its various products, substantially the same amount as was spent last year, but only 33 per cent. of the 1937 budget as compared with 40 per cent. last year. About 19 per cent. of the total research budget will be spent in efforts to improve manufacturing methods and thus pave the way for lower prices to steel consumers.

* * *

Two of the largest and oldest oil-field equipment firms in the East, both founded in 1880, were merged when Clark Brothers Company of Olean, New York, and S. R. Dresser Manufacturing Company of Bradford, Pa., consolidated on June 19. The latter is a manufacturer of gas engines and compressors, the former manufactures flexible pipe joints and pipe line equipment.

American Notes

The Pittsburgh Rolls Corporation, a large manufacturer of rolls, is modernising and expanding its equipment. Three air melting furnaces, formerly hand fired with coal, or oil fired, are being equipped with a modern pulverised coal burning system. In conjunction with the pulverised coal machinery, there is to be installed a complete coal handling system, permitting the unloading of coal from hopper cars, conveyance to elevators, and then to the pulverisers, entirely by mechanical means. Serious economies in fuel, fuel handling, and melting costs will be realised, it is claimed.

Because the power demands will be increased greatly, an electrical 22 kv. loop station is being erected. This is the latest type of transformer station designed to minimise the possibility of power shut-offs. The equipment will provide greater horse power capacity. Other additional equipment will include two new roll grinders designed by the firm, and a 1,300 cub. ft. air compressor. Added to an original six, these new roll grinders will give the mill a range in these machines of from 20 to 60 inches.

* * *

Benjamin Schwartz, director general of the Institute of Scrap Iron and Steel, announced that the New York chapter of the Institute had signed a two-year labour agreement. The contract establishes a 45-hour week and a 9-hour day, with all overtime, including Saturday, to be paid at the rate of one-and-one-third.

* * *

Research programmes in the steel industry this year will be more intensive than for any recent year, according to reports made by member companies to the American Iron and Steel Institute. More than £2,060,000 will be spent in research work this year, as compared with £1,840,000 in 1936 and £1,740,000 in 1929. In preparation for the expanded research programmes this year, additional research facilities and equipment valued at nearly £400,000 were put into use during 1936, increasing the total investment in equipment for steel research to nearly £1,600,000.

* * *

More than 2,350 engineers, metallurgists, chemists, physicists and other technicians are now employed in the research laboratories of the steel industry. In addition, almost 1,200 other employees of the industry devote part of their time to research work.

* * *

The reports also disclosed that a larger share of the research found in 1937 will be devoted to study of possible new markets and uses for steel. Twenty-eight per cent. of the money spent for research will go for such purposes this year, as compared with 22 per cent. last year.

* * *

(Concluded in previous column.)

Foundry and Laboratory Characteristics of Cupola Cokes

By HUGH O'NEILL, D.Sc., M.Met., and J. G. PEARCE, M.Sc., M.I.E.E.

(*Continued from page 50.*)

III. LABORATORY TESTS*

To obtain correlations between cupola and laboratory results the cokes were next examined by the following procedures:—

Chemical ..	*Analysis (cokes and slags)*	*Tables IX, X*
	Wet oxidation test ..	*XI*
	Combustibility ,,	*XI*
	Reactivity ,,	*XI*
Physical ..	*Shatter* ,,	*XIV*
	Calorific Value	*IX*
	Porosity	*XV*
	Compression Strength	*XV*
	Abradability	*XV*
Structural ..	*Macrostructure (Rose's Method)*	*XIV*
	Microstructure	*XVI*

Most of these tests are well known, but the following brief descriptions of some of them may be useful:—

Wet Oxidation Test.[1]—The rate of oxidation of carbon in the coke by a solution of chromic and phosphoric acids is determined. Graphite is oxidised more rapidly than "amorphous" carbon by these reagents, and so a high value of CO_2 as reported in the test results indicates a relatively large amount of graphite present in the sample. It has been suggested that high graphite is a desirable property in a metallurgical coke.

Shatter Test.—Coke is allowed to fall four times through 6 ft. on to a steel plate according to the procedure outlined in B.S.S. No. 496/1933. The shatter index was determined by sieving through both 2-in. and 1½-in. screens. A high shatter index means a high resistance to breakage both in transport and in the cupola stack, and frequently indicates good thermal properties. The index is expressed as the percentage weight remaining on 2-in. and 1½-in. screens.

Combustibility Test.—This is a measurement of the capacity of the coke to react with air. Coke is heated in a current of air or oxygen and its ignition temperature noted. This ignition temperature depends upon the apparatus used, and so the latter must be standardised. The rate of combustion is determined, as well as the maximum steady temperature obtained.

Reactivity Test.—This is a measurement of the extent of the reaction of coke with carbon dioxide. In the Fuel Research Board method[2] the volume of carbon monoxide obtained from 100 mls. of carbon dioxide gas when passed in a stream over cokes maintained at an arbitrarily selected temperature of 950 deg. C. under standard conditions is measured.

The "*RI value*" is the primary reactivity value of the coke as obtained above for the first 100 mls. of carbon dioxide, and has a theoretical maximum value of 200.

The "*RIII value*" is obtained by continuing the experiment until the volume of gas obtained from successive determinations is substantially constant. Reactivity values can be considered from three aspects, (*a*) the magnitude of RI and RIII, (*b*) the difference between RI and RIII, and (*c*) the smoothness of the curve obtained for the change from RI to RIII.

TABLE XI.—*Reactivity Tests.*

Coke reference.	Wet oxidation test. Mg. CO_2 per 2.5 hrs.	Combustibility test "A." Ignition temp. Deg. C.	Max. steady temp. Deg. C.	Combined gas analysis. CO_2.	CO.	CO_2:CO.	Consumption. Gm. per hr. Carbon.	Coke.	Reactivity test. RI.	RIII.
L1	204†	565	1,181	14.2	10.1	1.40	44.8	49.2	104	59
G1	201	559	1,175	14.7	9.6	1.53	45.2	49.6	90.5	47.5
P	141†	519	1,129	12.7	12.8	0.99	48.4	53.4	190.5	124
A	194	545	1,177	14.6	9.6	1.52	45.2	48.3	89	55
F	217	586	1,192	15.3	8.4	1.86	43.9	45.8	77.5	43
C	161	570	1,161	13.2	11.1	1.19	47.0	51.2	144.5	157
I	189	530	1,200	14.4	10.0	1.44	45.6	48.5	74	42
H	208	566	1,170	15.1	9.1	1.66	44.7	46.3	63.5	46
B	133†	528	1,164	13.8	10.5	1.31	46.3	50.2	100.5	118
E	230	561	1,163	15.0	8.9	1.69	44.5	48.3	68	38.5
M	186	522	1,188	14.4	10.0	1.44	45.6	49.9	126.5	64
K	167	566	1,112*	13.5	11.2	1.21	46.9	51.7	58.5	54
D	150	584	1,195	15.0	8.7	1.72	44.4	46.8	88.5	55
J1	144	550	1,174	14.5	9.8	1.48	45.4	49.3	14.5	27
316	218	560	1,190	14.2	10.1	1.41	45.8	49.1	107	70
317	178	490	1,160	14.4	10.1	1.43	45.6	49.4	132	61

* Falling temperature.
† Similar tests made in the B.C.I.R.A. laboratory gave L1 = 164, P = 119, B = 125.

Macrostructure by Rose's Method.—A typical piece of coke is coated with a mixture of plaster of Paris and magnesia, and is sectioned longitudinally with a hack saw after the coating has set. The sawn face is soaked in water and more coating material applied. After this has set the section is rubbed down with emery on a glass plate, and may be photographed to show the amount of fissuring in the coke. The latter is likely to bear some relation to the shatter index.

TABLE XIII.—*Nomenclature for Describing Macrostructure.*

	Descriptive terms employed (in order).
(1) *Form of pieces:*	
(*a*) Size	"Large," "medium," "small."
(*b*) Outline	"Roughly rectangular," "irregular," "segmental," "bent."
(*c*) Ratio of length to section— "prismatic index"	"Blocky," "fingery" or "prismatic."
(2) *Appearance of fissures in longitudinal section:*	
(*a*) Width	"Indistinct," "fine," "coarse."
(*b*) Extent	"Short," "long."
(*c*) Form	"Wavy," "straight."
(*d*) Spacing	"Widely spaced," "closely spaced."
(*e*) Degree of connection between different systems of fissures.	"Communicating," "disconnected."

Chemical Analysis

The results of chemical analysis are given in Table IX, the cokes being arranged as before in descending order of thermal merit. From the proximate analysis it is possible to calculate the approximate calorific value by means of an empirical formula dependent on the ash and volatile contents of the coke. The actual calorific power as determined in a bomb calorimeter is given alongside for comparison, and it will be observed that the agreement is good. The carbon content is perhaps the most important item in the chemical analysis of a coke, but is of no great utility in the present tests.

TABLE XII.—*Repeat Rose's Tests.*

Ref. on Fig. 4.	Batch period of sample.	Microstructure. Black cell wall. Linear per cent. Traverse 1.	Traverse 2.	Mean.
La	Original (1934) ..	47	53	50
Lb	1 year later ..	44	41	43
Lc	2 years ,, ..	46	43	45
Ca	Original (1934) ..	66	70	68
Cb	1 year later ..	30	43	37
Cc	13 months later ..	31	41	36
Ga	Original (1934) ..	54	56	55
Gb	2 years later ..	59	45	52

Cokes H and F are high in fixed carbon and low in volatiles, but they do not stand particularly high in the authors' practical order of merit. Coke F gave the highest carbon pick-up (see Table VII) and there is fair correlation between this quantity and the percentage of fixed carbon.

The compositions of the coke ashes are given in Table X together with those of the corresponding cupola slags.

After consideration of these chemical results it must be concluded that none of them determines sufficiently well the melting merits of the cokes.

Thermo-Chemical Laboratory Tests

The results of various reactivity tests are given in Table XI.

Detailed study of Table XI does not show that any of these laboratory results taken singly will indicate the melting merits of the cokes.

It emerges that by placing the specimens in the order of their wet oxidation test results they become segregated into groups of the appropriate coalfields. The indicated order of decreasing graphite content is as follows:—South Wales, Durham, Scotch, South Yorkshire and Lancashire. This method of coalfield grouping will be considered later.

* Tables VII, IX, X and XIV were reproduced with the first two sections of this Paper in last week's issue of the FOUNDRY TRADE JOURNAL.

1 H. Blayden and H. Riley, J. Soc. Chem. Ind., 1935, **54**, 159 T.

2 "The Reactivity of Coke" (2), Fuel Research Paper No. 22. H.M. Stationery Office, 1929.

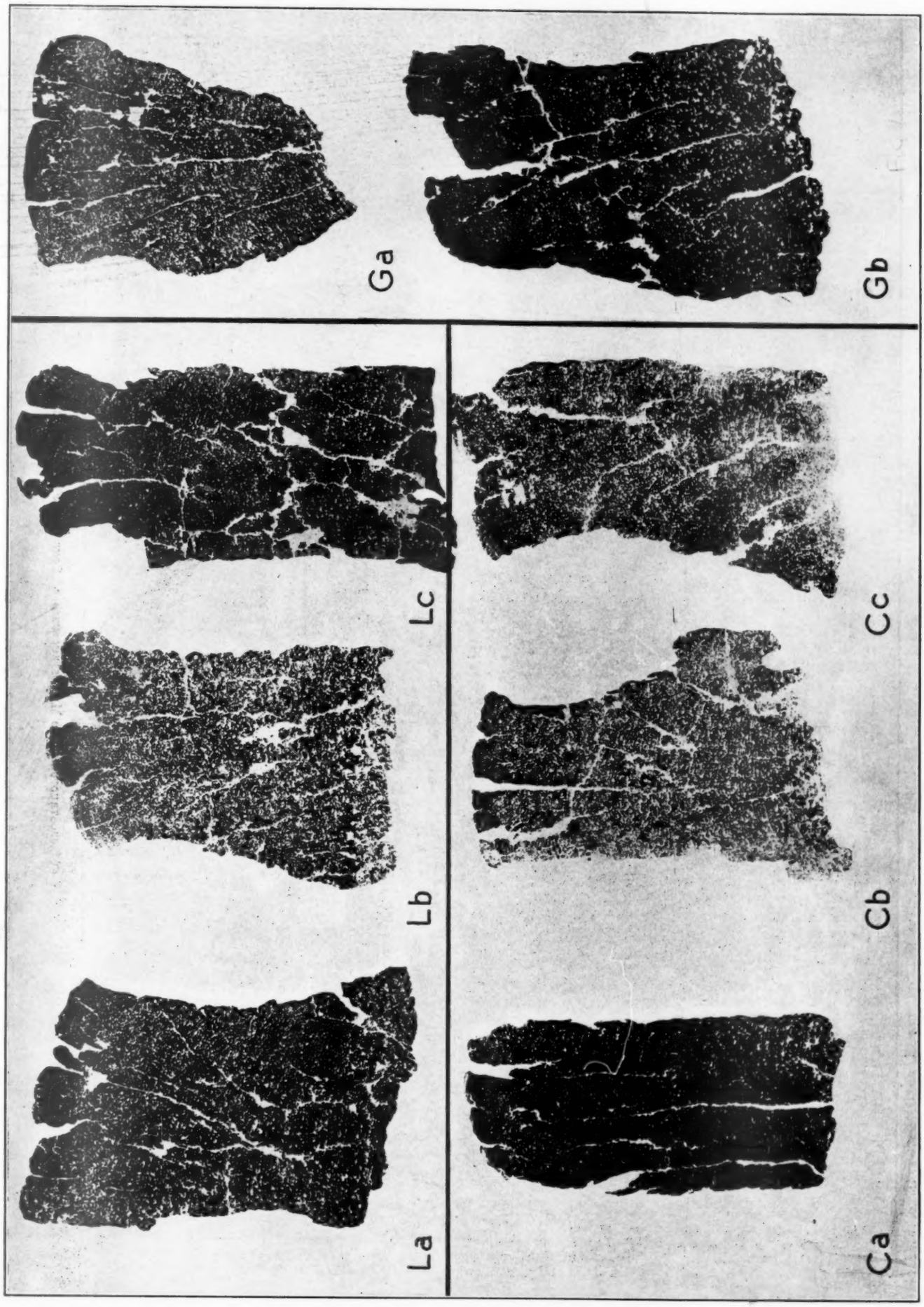

FIG. 4.—ROSE'S TEST ON THE MACROSTRUCTURE OF COKE.

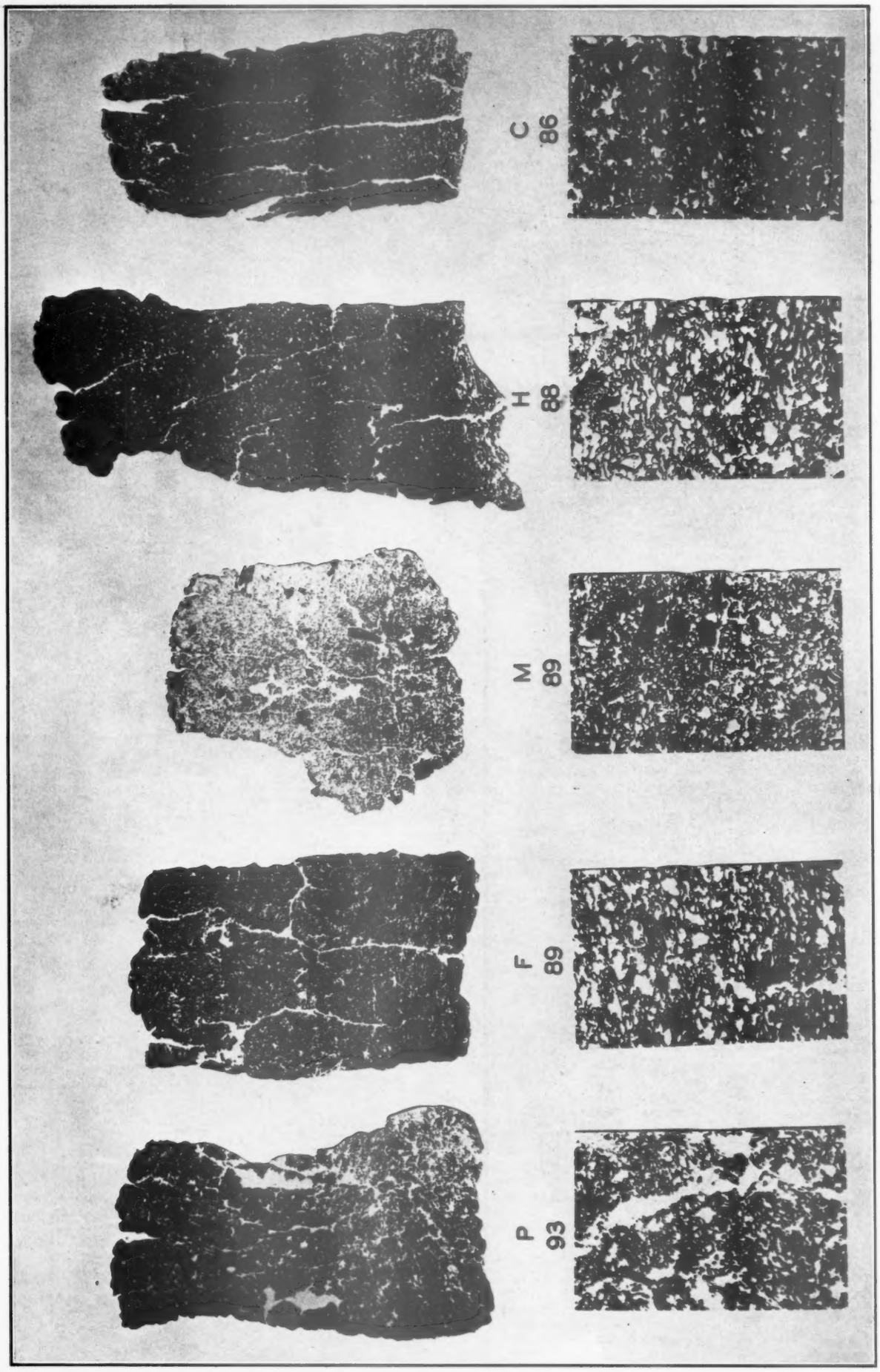

FIG. 5.—MACROSTRUCTURES AND MICROSTRUCTURES OF COKES, P, F, M, H, AND C.

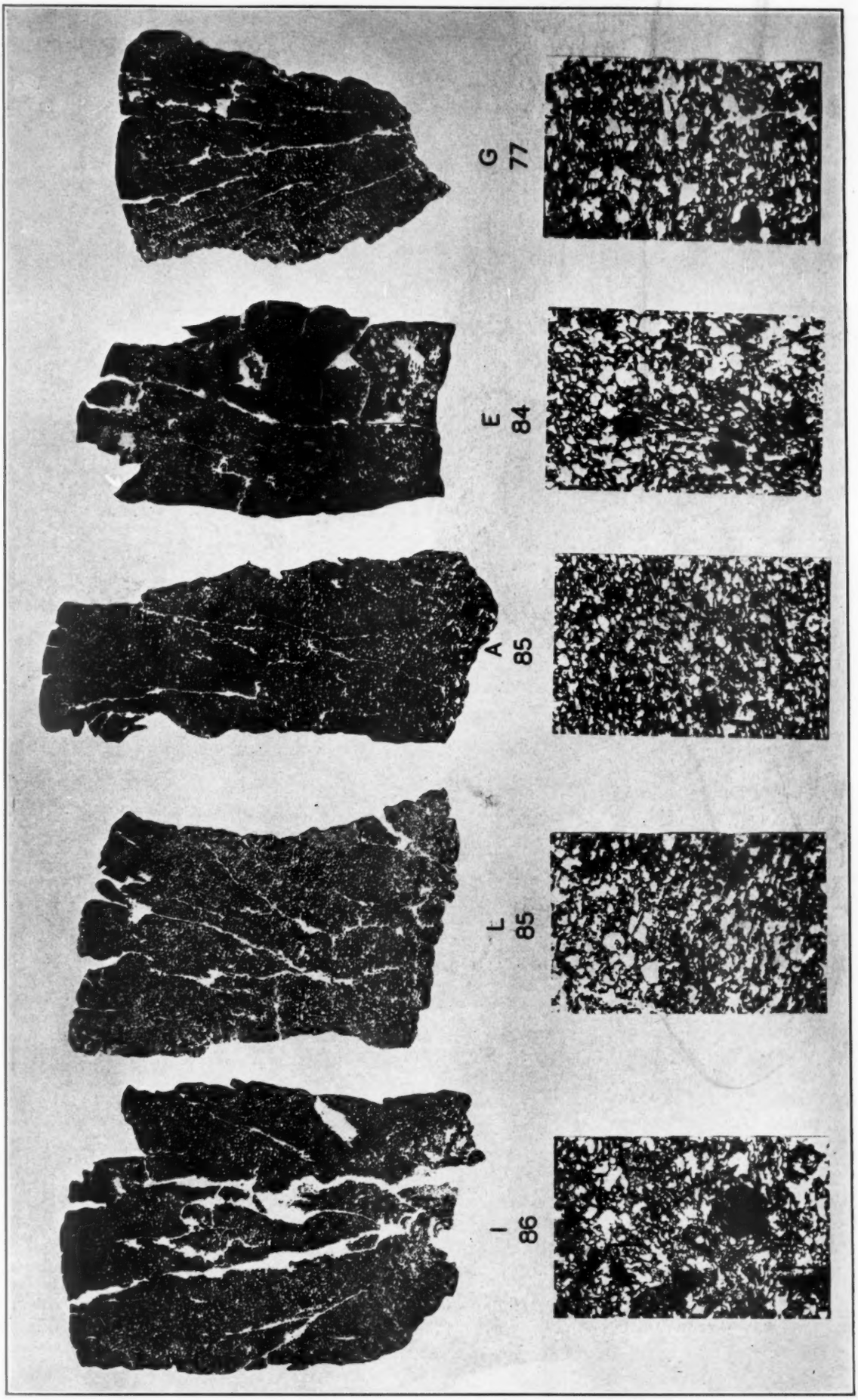

FIG. 6.—MACROSTRUCTURES AND MICROSTRUCTURES OF COKES I, L, A, E, AND G.

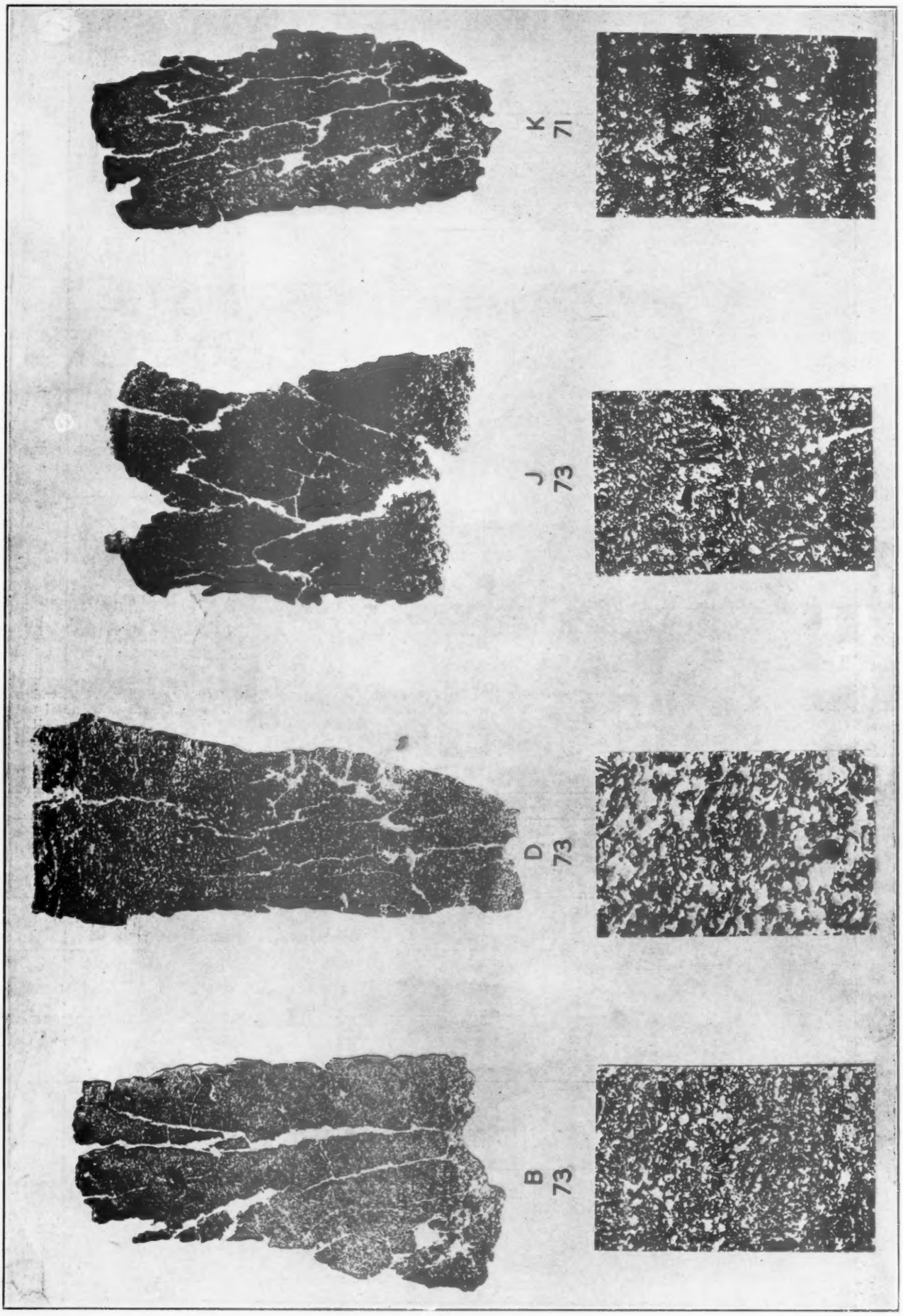

FIG. 7.—MACROSTRUCTURES AND MICROSTRUCTURES OF COKES B, D, J, AND K.

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Macrostructure

The preparation of sections of coke by Rose's method presents no difficulties, but the question arises as to whether a selected piece can legitimately serve as a sample for a given brand. Besides the macrostructure, the cell formation has also been examined in the way described later in this Paper. The authors are of the opinion that cokes L and G have maintained a structural consistency during the time period

TABLE XV.—*Properties of Cellular Structure.*

Coke Ref. in order of melting temp.	Apparent porosity.* Per cent.	Compressive breaking stress. Lbs. per sq. in. ¾-in. cube.	½-in. cube.	Representative value.	Abrasion tests. L.M.S. resistance index (10⁵/C.).	N.C.R.C. resistance index‡ per cent. on 72 B.S.S.
L	46	1,670	1,560	1,610	65.5	66.0
G	45	—	3,050 1,469 1,555 1,665	1,560	—	65.5
P	48	—	1,158 1,220	1,190	—	57.0
A	48	1,210	1,295 1,270	1,280	64.5	61.5
F	48	—	—	—	—	—
C	46	1,760 2,280	1,040	2,020	75.5	68.0
I	47	—	2,800 1,553 1,665	1,610	—	61.0
H	50	1,560	1,210	1,560	—	63.5
B	43	—	—	—	—	55.5
E	45	—	1,610 1,610 1,360	1,530	74.0	66.5
M	46	—	1,550 1,700 1,665	1,640	—	57.5
K	40	—	3,610 5,410	4,510	57.5	59.5
D	48	1,870	2,480 2,380	2,430	65.5	62.0
J	46	—	1,610 1,760 2,060	1,810	61.0†	55.5
316	44	—	—	—	—	61.5
317	53	—	—	—	—	57.0

* Average of four " cage " tests. † Repeat gave 60.5; the others are single tests. ‡ Mean of three tests.

The authors have not seen this point dealt with very fully, and their own examination of it has only been slight.

In selecting a sample for macrostructure the aim was to obtain an average piece showing both the " cauliflower end " (*i.e.*, portion adjacent to oven wall) and the inner coke. Fig. 4 illustrates the appearance of sections of brands L, C and G sampled from different deliveries over periods of time as reported in Table XII.

mentioned, and that a selected macrospecimen has given a reliable indication of structure. Coke C, however, has changed, for whilst Cb and Co duplicate quite well, they differ greatly from Ca. From quite an independent source the authors have heard that coke C is variable in quality for cupola work. The general form of the cokes and the points to be noticed in the macrostructure have been described according to the scheme set out in Table XIII.

TABLE XVI.—*Correlation of Tests.*

Coke reference.	Structural. Cell structure group (see Fig. 9).	No. of cells per cm.	Black cell wall. Linear per cent.	Thermal. Cupola melting temp. Deg. C.	RI–RIII reactivity values.	Mechanical. Shatter Index. (2 ins.)	Compression strength. Lbs. per sq. in.	N.C.R.C. abrasion resistance. Per cent. on 72 B.S.S.
L	Rather open ..	16	50	1,330	45.0	85	1,610	66.0
F		17	52	1,310	35.0	89	—	—
A		15	54	1,310	34.0	85	1,280	61.5
G	Mixed	17	55	1,320	43.0	84	1,560	65.5
I		15	60‡	1,305	32.0	86	1,610	61.0
E		17	53	1,295	30.0	84	1,530	66.5
H		20	52	1,300*	17.5	88	1,560	63.5
C	Dense and uniform	18	68	1,305	−12.5	86†	2,020	68.0
J		22	67	1,270–95	−12.5	73	1,810	55.5
K		23	65	1,290	4.5	71	4,510	59.5
B		24	64	1,300	−17.5	73	—	55.5
P	Rather open ..	25	51	1,315	66.5	93	1,190	57.0
D	Do. (Beehive)	18	51	1,290	33.5	73	2,430	62.0
M	Dense	24	58	1,295*	62.5	89	1,640	57.5
316	—	25	51	1,295*	37.0	87	—	61.5
317	—	19	63	1,290*	71.0	91	—	57.0

* Coke was of small size and temperatures are liable to be low.
† Previous values for this coke are 79 to 83 (see Table XIV), and it is said to be variable.
‡ Unduly high value caused by large amount of black mineral matter in section.

The upper portions of Figs. 5, 6 and 7 are reduced photographs of the longitudinally sectioned cokes arranged from left to right in decreasing order of shatter index (2-in. screen). A description of the structures is attempted in Table XIV.

Shatter Properties

The results for the shatter test will be found in Table XIV, and since the 2-in. screen values give a more open scale than the 1½-in., the former have been adopted for purposes of reference. There is a suggestion that cokes of small original size sometimes yield shatter values rather higher than the average. Results obtained several months before the present research commenced are also given and indicate reasonable regularity of values for the various brands.

There is a slight indication from Table XIV that the shatter indices are decreasing as the

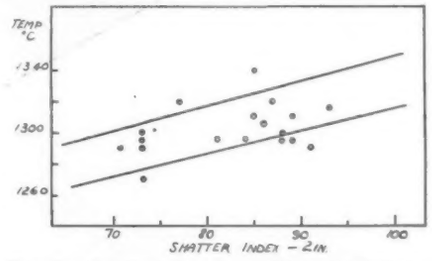

FIG. 8.—SHATTER INDEX AND MELTING QUALITY.

cupola merit of the coke decreases. Fig. 8 shows this effect graphically, and whilst the generalisation is to be taken very broadly, the authors find that shatter index is a more consistent guide to the merit of cokes from *any* coalfield than any other single laboratory test result examined in the present investigation. *Cokes with a shatter index (2 in.) of less than 80 have not given the best results in these trials and might always be viewed as doubtful for cupola purposes.*

It is difficult to establish a precise correlation between macrostructure and shatter value, but if the longitudinal fissures are distinct, long and clearly connected to a distinct system of transverse fissures enclosing only small prismatic areas of coke, then the shatter test result will be low. Thus it will not be surprising that coke K is the most easily shattered of the series.

(To be concluded.)

Iron and Steel Production

The British Iron and Steel Federation reports that there were 126 furnaces in blast at the end of June, compared with 122 furnaces at the end of May, six furnaces having been blown in and two furnaces having ceased operations during the month. The production of pig-iron in June amounted to 699,300 tons, compared with 696,300 tons in May and 644,100 tons in June, 1936; the month's production included 146,800 tons of hematite, 399,100 tons of basic, 122,200 tons of foundry and 12,800 tons of forge pig-iron. The production of steel ingots and castings in June amounted to 1,106,400 tons, compared with 1,047,300 tons in May and 965,900 tons in June, 1936.

A Core Blowing Development

We regret that the reference contained in an article printed on page 52 of our July 15 issue, and carrying the above caption, was wrong. It should have been February 14, 1935, page 122. The article actually referred to (March 11, 1937, page 216) was a Paper read by Mr. V. Stobie, and dealt with an entirely different system of core making. We apologise to both the Coggon Foundry Equipment Company, Limited, and to Mr. Stobie for this lapse.

Sheepbridge Pig Iron

for **Forge** and **Foundry** purposes

Approximate Analyses.

	NEWBOLD		FOUNDRY					FORGE
	No. 3	Fdry. 4	Silky	No. 1	No. 2	No. 3	No. 4	No. 4
Carbon (graphitic)	3·20	3·00	3·50	3·70	3·50	3·25	3·10	2.80
„ (combined)	0·30	0·40	0·04	0·08	0·12	0·24	0·30	0·50
Silicon	2·0 to 3·0	2·0 to 3·0	4·0 to 5·0	2·5 to 4·0	2·5 to 4·0	2·0 to 4·0	2·0 to 3·5	2·0 to 3·0
Sulphur	0·03	0·04	0·01	0·01	0·02	0·03	0·04	0·06 to 0·08
Phosphorus	0·75	0·75	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5
Manganese	1·3 to 1·5	1·2 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·2

Stocked in ranges of 0·5% silicon increments.

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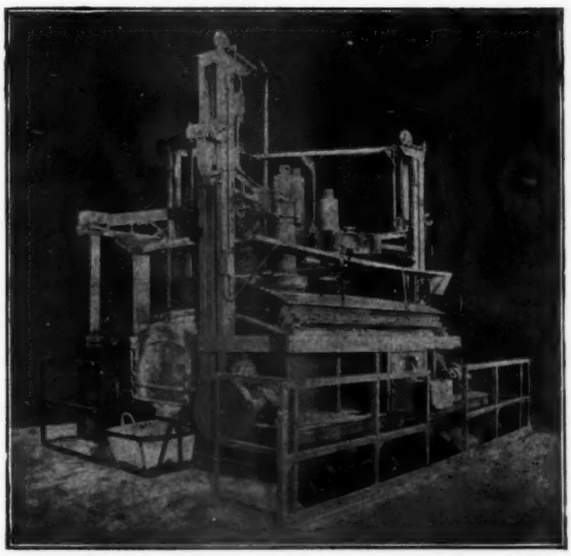

NON-FERROUS METAL MELTING ELECTRIC FURNACES

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This Week's News in Brief

Trade Talk

LORD LONDONDERRY started the machinery in the new works of Durham Cables, Limited, at Birtley, on July 14.

WALTER SLINGSBY & COMPANY, LIMITED, malleable ironfounders, Woodhouse Road, Keighley, are to extend their works.

DAVID BROWN & SONS (HUDD.), LIMITED, have opened new branch offices at Prudential Buildings, Colmore Row, Birmingham, 3.

THE ROOF of the foundry of Alexander Brown & Son, Limited, Foyle Street, Londonderry, was extensively damaged by fire recently.

NEARLY 90 PER CENT. of the available exhibiting space for the 1938 British Industries Fair at Birmingham has already been applied for.

IN NEW ZEALAND an Order in Council has been issued which prohibits the export of cast-iron scrap without the consent of the Minister of Customs.

A MUNICIPAL AND INDUSTRIAL EXHIBITION is to be held in Chesterfield from October 6 to October 16. Many local iron and steel concerns have already taken space.

THE BROOMSIDE FOUNDRY, Bonnybridge, belonging to the Broomside Foundry Company, Limited, was damaged by a fire which broke out in a storage shed last Friday.

FRANK PERKINS, LIMITED, Diesel engine manufacturers and general engineers, of Queen Street and Deacon Street, Peterborough, are to erect a larger factory near Newark.

BORAX CONSOLIDATED, LIMITED, announce that their works at Belvedere, Kent, will be closed from August 1 to 8 inclusive, on the occasion of their employees' annual holiday.

THE ADDRESS of the International Meehanite Metal Company, Limited, is now 14 to 20, Gaskin Street, London, N.1, the London County Council having renamed Church Street.

THE BERRISFORD ENGINEERING COMPANY, LIMITED, Stoke-on-Trent, have received a contract for a dry-cleaning plant for coal, to be erected for the Stafford Coal & Iron Company, Limited.

THE SOUTH DURHAM STEEL & IRON COMPANY, LIMITED, have put another furnace into operation at their Seaton Carew Works. This brings the number in blast on the North-East Coast to 35.

HEAD, WRIGHTSON & COMPANY, LIMITED, have recently completed at their Eggleseliffe Foundry a casting which weighs 40 tons and is nearly 40 ft. long and 9 ft. wide. It is one section of a table for a large planing machine.

NEW CLUB PREMISES, which cost about £5,000, the gift of the directors of the Lancashire Steel Corporation, Limited, to the employees at the Irlam works, were opened on July 10 by Mr. John E. James, chairman and managing director.

THE FORD MOTOR COMPANY, LIMITED, Dagenham, Essex, last Thursday had as their guests about 200 suppliers and contractors to tour their works. Invitations were sent to those who had co-operated in the building and development of the Ford Works at Dagenham, and to suppliers of material.

AT THE International Commercial Fair, Smyrna (Izmir), Turkey, which is being held from August 20 to September 20, an inquiry bureau will be maintained, under the direction of His Majesty's Consul-General at Smyrna, for the purpose of providing information regarding United Kingdom trade matters.

FOR THE THIRD YEAR in succession, the Old Trafford works of Switchgear & Cowans, Limited, are being extended. The new additions, which are now nearing completion, are mainly to be devoted to extensions of the machine and erection shops, but it is of interest to note that a works canteen and welfare centre have been included.

THE SECOND annual general meeting of the British Foundry School will take place at 3 p.m. on July 27, 1937, at the Education Offices, Margaret Street, Birmingham, by courtesy of the Chief Education Officer. The meeting will be held in Committee Room C, on the first floor, and all interested in the work of the School are invited to be present.

GLASGOW IS TO BE the first local authority to organise a municipal collection of scrap iron, so that the cleansing department can take advantage of current prices. The department for the year ended May 31 sold scrap to the value of £6,000, but it is believed that this figure can be doubled easily in the current year if householders will respond to the instructions to be issued at the end ot this month.

NEW DETERMINATIONS have been made by the Victorian Wages Board (New South Wales) in various industries. Jobbing moulders or coremakers have received an increase of 3s. a week, while machine or plate moulders or coremakers have a classification ranging from 78s. to 89s. a week. Special overtime rates of time and a-half for the first four hours, and double time thereafter, have been provided for moulders (except pipe moulders). These rates are now in operation.

THE GLANMOR FOUNDRY COMPANY, LIMITED, of Llanelly, have recently completed a 26-ton steel casting which is the largest produced in South Wales. Amongst the larger castings which the firm have just completed, or are now handling, are four 17½-ton steel housings, four steel side frames for a strip coiler, weighing 8 tons each, two 20-ton billet-shear housings for the new Ebbw Vale works of Richard Thomas & Company, Limited; eight 24-ton rolling-mill housings for Turkey; four steel housings for India, weighing 21 tons each, and a 14¾-ton baseplate for a hydraulic press, to be installed at the Scunthorpe works of the United Steel Companies, Limited.

A NEW SCHEME for training apprentices is shortly to be introduced by Colvilles, Limited. The minimum age at which lads may start their apprenticeship is 16. Examinations will be held yearly to find out whether lads of 18 and over are qualified for special tuition in technical subjects, and three youths will be selected for training at the central drawing office at Motherwell, where they will be given a four-years' course in design and the application of technical principles. The scheme is designed to ensure a supply of trained men, and the selected apprentices will be given an all-round training covering every phase of activity undertaken by the firm. Similar facilities are to be provided for youths training as chemists and metallurgists.

LAST THURSDAY a number of the staff and students of the Sir John Cass Technical Institute, Jewry Street, Aldgate, London, E.1, made their fifteenth annual visit to metallurgical works in Birmingham. During the morning they inspected the Phœnix Street works of the Phœnix Steel Tube Company, Limited, by whom they were afterwards entertained to luncheon. Mr. G. Patchin, A.R.S.M., M.I.M.M., Principal of the Institute, proposed a vote of thanks to the company, on whose behalf Mr. C. J. Moon, commercial manager, replied. The afternoon was spent at the works of Hudson & Wright, Limited, manufacturers of non-ferrous seamless tubes, in Halberton Street, and here the students saw this country's largest vertical extrusion press in operation. Mr. Patchin, on behalf of the students, thanked the company for the facilities they had granted for the inspection of their plant, and Mr. H. T. Evans replied.

Company Reports

John Baker & Bessemer, Limited.—Dividend on the 6 per cent. cumulative preference shares for the half-year to June 30.

Crossley Bros., Limited.—Dividend of 5 per cent. for the year ended April 30 last on the 7 per cent. non-cumulative preferred ordinary shares.

Wellman Smith Owen Engineering Corporation, Limited.—Net profit for the nine months ended March 31, £20,947; dividend of 7½ per cent.; carried forward, £11,656.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Thermic Equipment & Engineering Company, Limited, Dibdale Works, Dudley, Worcs.—Capital, £3,000. Manufacturers of gas-fired furnaces, gas, oil, coal or coke-firing equipment, etc. Directors: T. Allen, M. van Marle, W. E. Gibbons, and J. S. Lowe.

Personal

MR. J. DEARDEN, B.Sc., has changed his address from Birmingham to 1, Huntley Drive, Cambuslang, Glasgow.

SIR W. BENTON JONES, BT., has been re-elected President of the Sheffield Exchange (coal, iron, steel and allied trades).

MR. S. N. LOOSEN, works manager of the Coronium Metal Company, Limited, of Reading, has joined the board of the Anti-Attrition Metal Company, Limited.

MR. G. H. CLAMER, a Past-President of the American Society for Testing Materials and the American Foundrymen's Association, has been elected an honorary member of the former body.

MR. R. R. DEAS, JUNR., chairman of the Birmingham Chapter of the American Foundrymen's Association, and a member of the staff of the American Cast Iron Pipe Company, arrived in London last Monday, together with two of the principal executives of that concern.

MR. H. E. HARRIS, M.I.Mech.E., has been appointed to the board of Asa Lees & Company, Limited, textile machinery experts, of Oldham. He is, in addition, controller of purchases to the group of firms forming the merger of Textile Machinery Makers, Limited, of Manchester, and will be responsible for centralisation of the whole of the purchases required by the 14 members of that group.

Obituary

MR. ALFRED EDWARDS, who died recently at the age of 70, was for 55 years on the staff of the Butterley Company, Limited.

SENATOR MARCHESE MARCONI, whose pioneer activities in the development of wireless telegraphy brought him international fame, died in Rome on Tuesday, at the age of 63 years.

WE SINCERELY REGRET to announce the death of Mr. Harold N. Davis, who died last Sunday at his home near Luton, at the age of 64. Mr. Davis started his business at the Diamond Foundry, Luton, which was established in that town about 50 years ago. In 1895, Mr. Davis became associated with the Langley Street Foundry, a concern taken over by the Davis Gas Stove Company, Limited, in 1900. About this time activities extended to Scotland, and a second Diamond Foundry was created in Falkirk. The Diamond Foundry at Luton was rebuilt in 1907, with Mr. Harold Davis as managing director, and production was concentrated therein, which meant the closing down of the Scottish and Langley Street foundries. This concern now employs over 2,000 operatives. When Radiation, Limited, was formed, he was included in the directorate. Mr. Davis was an enthusiastic advocate of the continuous-casting system, and the plant under his charge was one of the first to be mechanised. To Mr. Kenneth Davis, his son, who has for the last seven years been closely associated with him as a director, we extend our sincere sympathy.

A Shot-Blasting Development

The Weirton Steel Company, of Weirton, West Virginia, has, according to "Steel" installed a specially designed shot-blasting plant for the purpose of communicating a roughened surface to sheets. The process involves the actual shot blasting of the cold rolls for producing strip, and the object is to prevent slipping of the strip during pressing operations.

Industrial Law

The Industrial Welfare Society is again arranging to hold a lecture course on industrial law at the headquarters of the Society, 14, Hobart Place, Westminster, London, S.W.1, beginning on October 4, and continuing each Monday for ten weeks. It will be conducted by Mr. H. Samuels, M.A., Barrister-at-Law (author of "The Law Relating to Industry," "The Law Relating to Shops," etc.). The course is intended for all persons engaged in executive work in industry and commerce (managers, company secretaries, welfare workers, industrial medical officers and nurses, etc.), as well as for persons intending to take up such posts. The fee for the course is £2 2s. (executives of member firms £1 12s. 6d.). Application for enrolment should be sent immediately to the secretary, from whom further particulars can be obtained.

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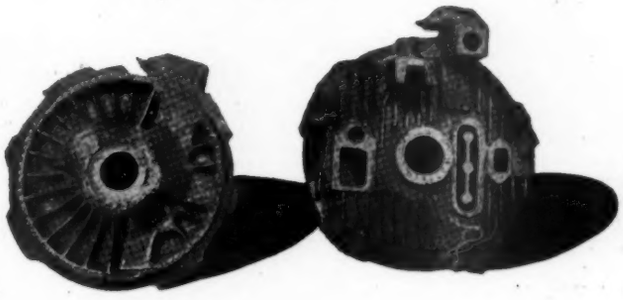
Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.



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SWANSEA OFFICE: Metropole Chambers, Wind St., Swansea. Telephone: 3680 Telegrams: "Genefax, Swansea" (Mr. D. F. Hood-Williams)

MANCHESTER OFFICE: 9, Albert Square, Manchester, 2. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester" (Mr. S. G. Throssell)

MIDDLESBROUGH OFFICE: Halifax Bldgs, Exchange Place. Telephone: Middlesbrough 3313 Telegrams: "Genefax, Middlesbrough"

CARDIFF OFFICE: 17, Windsor Place. Telephone: 5796 Telegrams: "Genefax, Cardiff" (Mr. F. E. Rutter)

Other Moulding Sands include—Zenith Red Sand, York Yellow 102 Sand, Scottish Rock Sand, Bramcote Red Sand, Harperley Sand, Hensall Sand, Red Rover Sand, Warsop Sand, Mansfield Sand.

Raw Material Markets

The demand for both iron and steel is unabated and far in excess of current production; and while makers are anxious that their plans for the expansion of output should not be carried too far, as has been done in the past, they fully realise that the capacity of their plants must inevitably be extended, and schemes with this object in view are being carried out. The holiday seasons is commencing and Clydeside has been idle this week. The temporary closing of works in the various districts should help to ease the pig-iron situation and provide an opportunity for makers to overtake some of their arrears. The shortage of foundry iron continues very pronounced. The Spanish ore situation is causing a certain amount of anxiety owing to the preference which General Franco is said to be about to accord Germany in the matter of supplies.

Pig-Iron

MIDDLESBROUGH.—Deliveries of pig-iron in this area are quite insufficient to meet the current requirements of consumers, but producers are dealing with the abnormal situation as fairly as possible. For deliveries in Middlesbrough and district, No. 3 Cleveland G.M.B. is quoted at 101s., with an extra 3s. for Falkirk deliveries and 6s. for Clydeside. No. 1 grade is charged at 2s. 6d. per ton more than No. 3. Hematite makers are also faced with an enormous demand and current outputs are totally inadequate to combat the pressure of inquiries. Producers are compelled to neglect offers from abroad, although they could secure very much higher prices in the export market. The minimum home quotation for mixed numbers is 122s. 6d., less 5s. per ton rebate.

LANCASHIRE.—Consumers generally are actively employed. While the textile machinists appear to be able to maintain a good rate of working, the light-castings founders are not so well placed as regards pig-iron supplies. Some jobbing founders also are experiencing difficulty in this respect. For delivery to consumers in the Lancashire price zone, quotations for Derbyshire and Staffordshire brands of No. 3 foundry iron are on the basis of 109s., with Northants at 107s. 6d., and Derbyshire forge iron at from 104s. to 106s. Scottish No. 3 foundry for delivery in the Manchester district is quoted at 137s. 6d., with West Coast hematite at 131s. and East Coast at 130s. 6d. delivered.

MIDLANDS.—Although it would appear that consumers are now less insistent in their demands for new business, the pressure is likely to be renewed at an early date. The temporary easing off has given makers an opportunity to give additional consideration to their delivery position. While business with the Continent and the United States appears to be negligible at the present time, considerable tonnages have been received from these sources in the past, and have helped to supplement the urgent inquiry. The current Association figures for ordinary No. 3 iron delivered to Birmingham and Black Country stations are 103s. 6d. for Northants No. 3 and 106s. for Derbyshire, Lincolnshire, and North Staffordshire No. 3, with 5s. less for forge iron. There continues to be a fairly good turnover in the special grades of iron. The general engineering, jobbing and motor sections are using these materials, the prices of which vary from about £6 5s. to £7 5s., according to transport costs. Hematite makers generally are well sold, and little new business can be undertaken. East Coast No. 3 is quoted at £6 13s. 6d. and West Coast mixed numbers at £6 14s. 6d., delivered the Midlands. An additional 1s. 6d. per ton is charged if delivery into works is stipulated.

SCOTLAND.—The annual holidays at the consuming plants are being taken this week and pig-iron makers are hoping to reduce delivery arrears to some extent. It is not expected that any appreciable difference will be brought about, however. As a result of the labour disputes in the United States steel industry, increased tonnages have been despatched to Scotland. Foundry No. 3 is quoted at 113s., with No. 1 at 115s. 6d., f.o.t. furnaces. No. 3 Cleveland is quoted at 104s. f.o.t. Falkirk and 107s. f.o.t. Glasgow. Mixed numbers of East Coast, West Coast and Scottish hematite are unchanged at 123s., less rebate, with basic, English and Indian, at 100s., and Scottish at 107s. 6d., all delivered steelworks and less rebate.

Coke

Foundry coke remains difficult to obtain and quotations are very firm. It has been suggested that prices will still further advance, but no changes have been intimated as yet. Good foundry coke from Wales or Durham is quoted at a minimum of 50s. per ton for delivery to Birmingham and district. The Welsh grades vary in price according to quality, but the maximum figure does not exceed 62s. 6d.

Steel

The effect of the holiday season in the producing districts is now apparent, and this has accentuated the difficulty of placing orders and securing deliveries, says the official report of the London Iron and Steel Exchange. The situation of the steel-works has been strengthened by the purchases of foreign iron arranged by the British Iron and Steel Federation; but there is a distinct shortage of hematite. The demand for semi-finished steel continues at a high level, and, although the British works producing this class of material are operating at capacity, the output is much below the requirements of the consuming industries. It is hoped that the imports of this description of steel, as the result of the reduction in the duties, will considerably improve the position of consumers. The home demand for finished steel shows no sign of subsiding, and the requirements of the market are well in excess of the available supplies.

Scrap

It is satisfactory to report that consumers now are generally finding it easier to obtain supplies of scrap. Increased tonnages are being imported; the price of this material naturally is considerably higher than that of home-produced scrap. In some parts of the country, however, consumers are still experiencing the utmost difficulty in procuring adequate tonnages. The Iron and Steel Corporation's efforts to stimulate the supply of scrap is believed to be working quite well, but some considerable time must inevitably elapse before the full benefits of the scheme can be ascertained.

Metals

Another week of good trading has been experienced on the non-ferrous metal markets, and in spite of holiday influences which usually tend to make this a dull period, a fair tonnage has changed hands.

Copper.—An easy tone has characterised business in this country, although inquiries have been on a heavier scale following improved labour conditions in the United States. While new business in the United States is quiet, consumers generally have only meagre tonnages on hand and are likely to enter the market in the near future. The world's June copper statistics, which revealed an increase in stocks of refined metal of 10,310 tons at 301,760 tons, and a decrease of 8,380 tons to 187,680 tons in apparent world consumption, have been well received on the whole. Rumours which are believed to have originated in London to the effect that leading copper producers have decided to restrict output are discredited in New York. Curtailment of production in July and August is thought possible in the south-west because of the hot weather, but any plan for reduction is thought unlikely. The Kennecott Copper Corporation is to build a new smelter costing $5,000,000 at Hurley (New Mexico) for its Nevada Consolidated and Chino mines. The smelter will be in operation at the end of 1938 and will handle the ore which is now shipped to the American Smelting and Refining Company under a long-term contract. In a recent interview Mr. Simon Guggenheim, President of the American Smelting & Refining Company, said that, with the general preparations in the world for rearmament, in addition to the demand which had come for industrial purposes, he felt confident that the consumption of all metals was sure to be very large. If there was going to be a general big consumption of other commodities copper was sure to benefit as well, said Mr. Guggenheim.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £55 3s. 9d. to £55 6s. 3d.; Friday, £55 12s. 6d. to £55 15s.; Monday, £56 to £56 2s. 6d.; Tuesday, £56 5s. to £56 6s. 3d.; Wednesday, £56 15s. to £56 16s. 3d.

Three Months. — Thursday, £55 10s. to £55 12s. 6d.; Friday, £55 15s. to £56; Monday, £56 2s. 6d. to £56 5s.; Tuesday, £56 7s. 6d. to £56 8s. 9d.; Wednesday, £56 13s. 9d. to £56 16s. 3d.

Tin.—Under the influence of increased American activity conditions in this market are firm. Consumers in the United States have bought more freely recently as a result of the easier tension in the labour dispute in the steel industry. Already the rate of operations at the tinplate mills has increased; this is a good sign, as order-books are filled to capacity and the strikes have already caused deliveries to be delayed to a considerable extent. The American tinplate output in May is estimated at 5,700,000 base boxes, as compared with 5,500,000 boxes a year ago The figure for January-May, 1937, is 26,400,000, against 20,400,000 in the corresponding period of last year. It is understood that the drought which has brought Malayan tin-mining almost to a standstill has broken. Five inches of rain has fallen throughout the Kinta Valley and most of the mines are resuming operations. A sub-committee of the International Tin Committee met in London on Monday. This sub-committee, which consists of representatives of all restriction countries, has the task of investigating the possibilities of preventing too much fluctuation in the tin market. It is stressed that the sub-committee is mainly academical in character, and only submits to the Tin Committee theoretical possibilities.

Official quotations have been as follow :—

Cash.—Thursday, £267 15s. to £268; Friday, £267 to £267 5s.; Monday, £266 10s. to £266 15s.; Tuesday, £267 to £267 5s.; Wednesday, £266 10s. to £266 15s.

Three Months.—Thursday, £265 15s. to £266; Friday, £265 5s. to £265 10s.; Monday, £265 5s. to £265 10s.; Tuesday, £265 10s. to £265 15s.; Wednesday, £265 to £265 5s.

Spelter.—There appears to be little of the holiday spirit about this market, and some heavy tonnages have recently been taken up. High-grade metal remains difficult to obtain, while supplies of ordinary grades are not too plentiful. In the United States, also, there is little to spare, and producers are actively employed in expanding their outputs.

Daily market prices :—

Ordinary.—Thursday, £22 16s. 3d.; Friday, £22 16s. 3d.; Monday, £22 13s. 9d.; Tuesday, £22 11s. 3d.; Wednesday, £22 12s. 6d.

Lead.—In direct contrast to the conditions prevailing in the spelter market, it would appear that there is something of a holiday atmosphere in the lead market. Deliveries to the building trade have been well maintained. Russia has continued to take up large tonnages. The American market is more active and consumers have taken up good tonnages.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £24 7s. 6d.; Friday, £24 7s. 6d.; Monday, £23 17s. 6d.; Tuesday, £23 10s.; Wednesday, £23 15s.

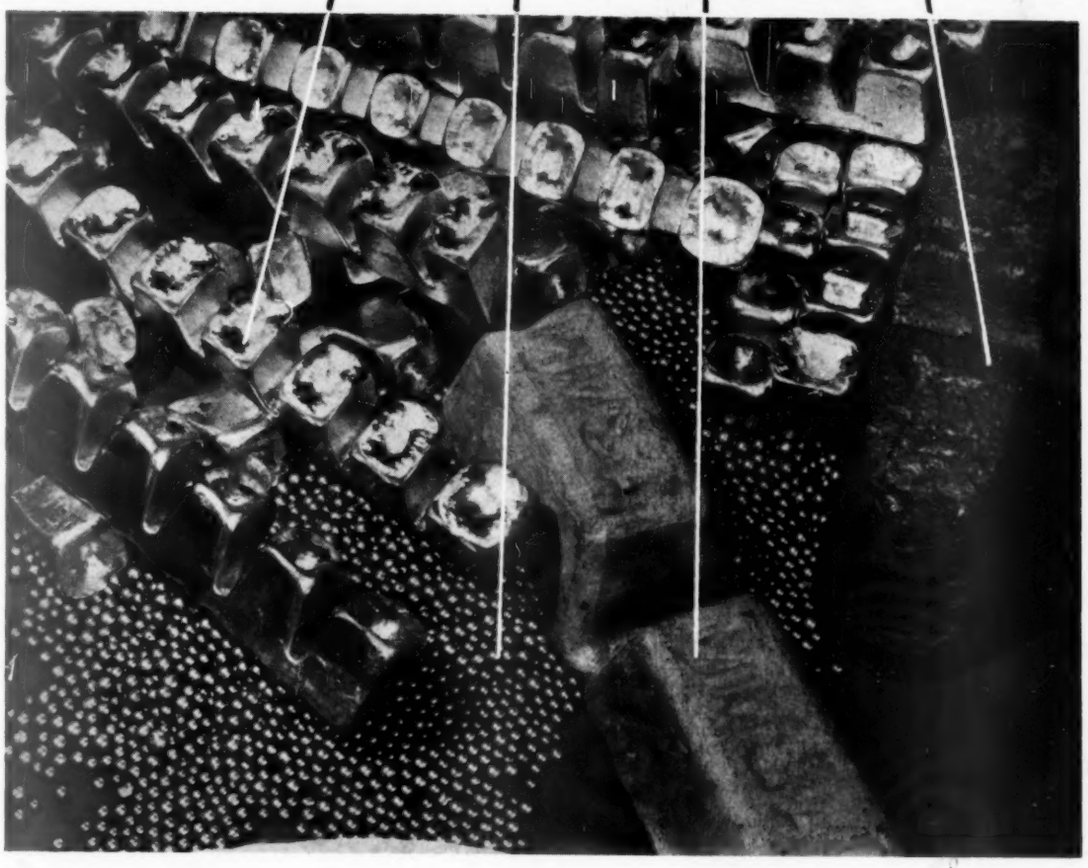
Scrap.—There continues to be a good turnover in scrap metal, and inquiries are on a satisfactory scale. Supplies generally are not difficult to obtain.

Approximate selling prices for old metal:—New aluminium cuttings, £82; rolled, £67; cast, £43; foil, £94 to £98. Copper, £51 to £57; braziery, £49. Clean brass, £32 to £36. Zinc, £15. Lead, £23 10s.; tea lead, £16. Gunmetal, £53.

Iron and Steel Scrap Campaign

The Rt. Hon. the Earl of Dudley presided over a luncheon given by George Cohen, Sons & Company, Limited, at Wood Lane, London, last Thursday. The purpose of the luncheon was to emphasise the importance of the national iron and steel scrap reclamation campaign which is being conducted by the British Iron and Steel Federation in conjunction with the National Federation of Scrap Iron and Steel Merchants. Lord Dudley expressed satisfaction that the campaign was yielding definitely satisfactory results. Mr. I. F. L. Elliot (director of the British Iron and Steel Corporation), who proposed the health of the agency firms, explained the events in the scrap market which led up to the formulation of the scrap control scheme, and he paid tribute to the agency firms for their aid, and especially their submission to voluntary restraints. Mr. Lawrence Levy (George Cohen, Sons & Company, Limited) thanked the Earl of Dudley for his presence as chairman at the luncheon.

Al + Ni + Mg + Cu



+ Scientific Control = B.A."Y" ALLOY

The technique of alloying calls for specialized metallurgical experience, and the attainment of uniformity is easier and more certain in the case of large industrial melts than in the small crucibles of the foundry. For these reasons small foundries should buy their alloys ready mixed. All the B.S.S. alloys and many other alloys for special purposes, mixed under the best possible conditions and using the best virgin metals, are supplied by the British Aluminium Co., Ltd.

THE **British Aluminium** CO. LTD

Head Office: ADELAIDE HOUSE, LONDON, E.C.4. **Telephone: Mansion House 5561 (6 lines).** **Telegrams: "Cryolite, London."**

F.T.J. 22.7.37

RAW MATERIALS—PRICE LIST

(Wednesday, July 21, 1937)

COPPER

	£	s.	d.
Standard cash	56	15	0
Three months	56	13	9
Electrolytic	63	5	0
Tough	62	10	0
Best selected	63	0	0
Sheets	93	10	0
India	74	15	0
Wire bars	64	5	0
Ingot bars	64	5	0
H.C. wire rods	67	15	0
Off. av. cash, June	55	15	$6\frac{3}{22}$
Do., 3 mths., June	55	2	$11\frac{5}{11}$
Do., Sttlmnt., June	55	15	$2\frac{8}{11}$
Do., Electro, June	62	5	$10\frac{10}{11}$
Do., B.S., June	62	6	$4\frac{3}{4}$
Do., wire bars, June	63	3	$7\frac{7}{11}$
Solid drawn tubes			$14\frac{1}{2}$d.
Brazed tubes			$14\frac{1}{2}$d.
Wire			$10\frac{1}{2}$d.

BRASS

Solid drawn tubes	$12\frac{1}{2}$d.
Brazed tubes	$14\frac{1}{2}$d.
Rods, drawn	$11\frac{1}{2}$d.
Rods, extd. or rlld.	$7\frac{1}{2}$d.
Sheets to 10 w.g.	10d.
Wire	$9\frac{1}{4}$d.
Rolled metal	$9\frac{1}{2}$d.
Yellow metal rods	$7\frac{1}{2}$d.

TIN

	£	s.	d.
Standard cash	266	10	0
Three months	265	0	0
English	267	12	6
Bars	268	10	0
Straits	267	10	0
Eastern	265	15	0
Banca (nom.)			—
Off. av. cash, June	249	19	$10\frac{7}{11}$
Do., 3 mths., June	249	3	$4\frac{10}{11}$
Do., Sttlmt., June	249	19	$9\frac{3}{11}$

SPELTER

	£	s.	d.
Ordinary	22	12	6
Remelted	20	10	0
Hard	19	10	0
Electro, 99.9	25	3	9
English	23	15	0
India	20	10	0
Zinc dust	30	0	0
Zinc ashes	7	10	0
Off. aver., June	21	9	$4\frac{1}{2}$
Aver. spot, June	21	8	$2\frac{9}{11}$

LEAD

	£	s.	d.
Soft foreign, ppt.	23	15	0
Empire (nom.)	24	6	3
English	25	15	0
Off. aver., June	22	16	$4\frac{4}{11}$
Aver. spot, June	22	17	$6\frac{12}{22}$

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.		£	s.	d.
Zinc sheets, English	36	0	0	to 36	10	0	
Do., V.M. ex-whse.	36	0	0	to 36	10	0	
Rods				30	10	0	

ANTIMONY

	£	s.	d.		£	s.	d.
English	82	10	0	to 83	10	0	
Chinese, ex-whse.				69	0	0	
Crude, c.i.f.				36	0	0	

QUICKSILVER

	£	s.	d.
Quicksilver	15	1	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£14 10 0
45/50%	£12 0 0
75%	£17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	5/- lb. (nom.)
Tungsten metal powder—	
98/99%	5/1½ lb. (nom.)
Ferro-chrome—	
2/4% car.	£34 15 0
4/6% car.	£24 5 0
6/8% car.	£24 0 0
8/10% car.	£24 0 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£38 5 0
Max. 0.5% car.	£41 0 0
70% carbon-free	10d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	8/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£16 15 0 to 17 5 0
76/80% packed	£17 15 0 to 18 5 0
76/80% export	£20 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 7d.
Finished bars, 18% tungsten	3s. 6d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

South Wales (West)—	£	s.	d.	£	s.	d.
Heavy steel, best	3	7	6 to	3	10	0
Mixed iron and steel	3	5	0 to	3	7	6
Heavy cast iron	3	8	0 to	3	10	0
Good machinery				4	0	0

Cleveland—	£	s.	d.	£	s.	d.
Heavy steel, best	3	6	6 to	3	9	0
Steel turnings				2	15	0
Heavy cast iron				4	7	6
Heavy machinery				4	10	0

Midlands—	£	s.	d.	£	s.	d.
Short heavy steel	3	17	6 to	4	0	0
Light cast-iron scrap				3	5	0
Heavy wrought iron	4	0	0 to	4	5	0
Steel turnings	2	2	6 to	2	5	0

Scotland—	£	s.	d.	£	s.	d.
Heavy steel, best	3	4	6 to	3	7	0
Ordinary cast iron				4	7	6
Cast-iron borings	2	0	0 to	2	2	6
Wrot-iron piling	4	13	6 to	4	15	0
Heavy machinery	4	13	6 to	4	15	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	47	0	0
Brass	30	0	0
Lead (less usual draft)	20	10	0
Tea lead	15	0	0
Zinc	14	10	0
New aluminium cuttings	74	0	0
Braziery copper	41	0	0
Gunmetal	45	0	0
Hollow pewter	165	0	0
Shaped black pewter	120	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	103/6
,, No. 3	101/-
,, No. 4	100/-
Forge No. 4	100/-
Hematite No. 1	123/-*
Hematite M/Nos.	122/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	123/-*
,, d/d Birm.	134/6*
Malleable iron d/d Birm.	160/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	103/-
,, No. 3 fdry.	106/-
Northants forge	100/6
,, fdry. No. 3	103/6
,, fdry. No. 1	106/6
Derbyshire forge	103/-
,, fdry. No. 3	106/-
,, fdry. No. 1	109/-
Scotland—	
Foundry, No. 1, f.o.t.	115/6
,, No. 3, f.o.t.	113/-
Cleveland No. 3, Glasgow	107/-
,, ,, Falkirk	104/-
Scottish hem. M/Nos. d/d	123/-*
Sheffield (d/d district)—	
Derby forge	100/6
,, fdry. No. 3	103/6
Lincs forge	100/6
,, fdry. No. 3	103/6
W.C. hematite	128/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	109/-
Staffs fdry. No. 3	109/-
Northants fdry. No. 3	107/6
Cleveland fdry. No. 3	109/-
Glengarnock, No. 3	137/6
Clyde, No. 3	137/6
Monkland, No. 3	137/6
Summerlee, No. 3	137/6
Eglinton, No. 3	137/6
Gartsherrie, No. 3	137/6
Shotts, No. 3	137/6

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)				13	5	0
Nut and bolt iron	11	12	6 to	11	17	6
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6

Bolts and nuts, ¾ in. × 4 in. 17 10 0 and up.

Steel—	£	s.	d.	£	s.	d.
Plates, ship, etc.	11	8	0 to	11	10	6
Boiler plts.	11	18	0 to	12	0	6
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5½ in.				12	0	6
Rounds under 3 in. to ⅜ in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
,, under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. (,,)				19	10	0
Galv. flat shts. (,,)				20	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	13½d.
Wire	15½d.
Rods	15½d.
Tubes	20½d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	36/-
Durham foundry	37/-
,, furnace	35/-
Scottish foundry	37/6
,, furnace	35/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	25/- to 26/-
,,	28×20 ,,	50/- to 52/-
,,	20×10 ,,	36/6 to 36/9
,,	18¾×14 ,,	26/3 to 26/6
C.W.	20×14 ,,	22/6 to 23/-
,,	28×20 ,,	46/- to 46/6
,,	20×10 ,,	32/- to 32/6
,,	18¾×14 ,,	23/- to 23/6

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	12	0	0	to 13	0	0	
Bars-hammered, basis	20	0	0	to 21	0	0	
Bars and nail-rods, rolled, basis	19	0	0	to 20	0	0	
Blooms	16	0	0	to 17	0	0	
Keg steel	27	0	0	to 30	0	0	
Faggot steel	20	0	0	to 25	0	0	
Bars and rods dead soft st'l	19	0	0	to 20	0	0	

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
July	15 ..	55	3	9	dec.	7/6
,,	16 ..	55	12	6	inc.	8/9
,,	19 ..	56	0	0	,,	7/6
,,	20 ..	56	5	0	,,	5/-
,,	21 .	56	15	0	,,	10/-

Electrolytic Copper

		£	s.	d.		
July	15 ..	61	0	0	dec.	20/-
,,	16 ..	63	0	0	inc.	40/-
,,	19 ..	62	15	0	dec.	5/-
,,	20 ..	62	15	0	No change	
,,	21 ..	63	5	0	inc.	10/-

Standard Tin (cash)

		£	s.	d.		
July	15 ..	267	15	0	inc.	20/-
,,	16 ..	267	0	0	dec.	15/-
,,	19 ..	266	10	0	,,	10/-
,,	20 .	267	0	0	inc.	10/-
,,	21 ..	266	10	0	dec.	10/-

Tin (English ingots)

		£	s.	d.		
July	15 ..	267	15	0	inc.	20/-
,,	16 ..	267	0	0	dec.	15/-
,,	19 ..	266	10	0	,,	10/-
,,	20 ..	267	0	0	inc.	10/-
,,	21 ..	267	12	6	,,	12/6

Spelter (ordinary)

		£	s.	d.		
July	15 ..	22	16	3	dec.	3/9
,,	16 ..	22	16	3	No change	
,,	19 ..	22	13	9	dec.	2/6
,,	20 ..	22	11	3	,,	2/6
,,	21 ..	22	12	6	inc.	1/3

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
July	15 ..	25	8	9	dec.	3/9
,,	16 ..	25	8	9	No change	
,,	19 ..	25	5	0	dec.	3/9
,,	20 ..	25	2	6	,,	2/6
,,	21 ..	25	3	9	inc.	1/3

Lead (soft foreign, prompt)

		£	s.	d.		
July	15 ..	24	7	6	dec.	8/9
,,	16 ..	24	7	6	No change	
,,	19 ..	23	17	6	dec.	10/-
,,	20 ..	23	10	0	,,	7/6
,,	21 ..	23	15	0	inc.	5/-

Lead (English)

		£	s.	d.		
July	15 ..	26	10	0	dec.	5/-
,,	16 ..	26	10	0	No change	
,,	19 ..	26	0	0	dec.	10/-
,,	20 ..	25	10	0	,,	10/-
,,	21 ..	25	15	0	inc.	5/-

Imports and Exports of Pig-iron, Castings, etc., in June and the Six Months 1937, compared with June and the Six Months 1936.

	June.		Six months.		June.		Six months.	
	1936.	1937.	1936.	1937.	1936.	1937.	1936.	1937.
	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Imports.								
Pig-iron—from British India	9,814	25,431	44,506	90,564	30,715	106,840	138,796	331,525
,, ,, Other British Countries	—	7,750	—	12,791	—	36,061	—	57,108
,, ,, Foreign Countries	2,754	42,628	21,062	74,733	14,207	217,798	98,620	405,043
Total	12,568	75,809	65,568	178,088	44,922	360,699	237,416	793,676
Castings and forgings	709	264	4,317	1,303	23,964	11,036	145,419	43,451
Cast pipes and fittings	49	127	591	543	2,284	3,639	22,239	15,546
Stoves, grates, etc.	46	38	344	296	4,601	6,405	37,967	43,051
Baths	413	735	3,223	4,995	10,568	19,697	81,514	121,681
Hollow-ware, all kinds	406	370	1,747	1,814	19,332	21,766	95,508	108,351
Exports.								
Pig-iron, forge and foundry	5,051	6,402	27,746	51,011	19,675	37,867	107,218	257,507
,, acid	2,026	2,805	16,305	29,449	7,472	16,006	56,861	154,614
,, basic	—	20	108	516	—	180	557	3,066
Total	7,077	9,227	44,159	80,976	27,147	54,053	164,636	415,187
Castings and forgings	293	358	2,129	1,780	11,444	15,569	79,702	67,851
Cast pipes and fittings, up to 6 in. diameter	3,432	4,995	26,861	30,208	40,072	59,476	303,023	326,391
,, ,, ,, over 6 in. ,,	2,380	4,317	20,359	21,115	19,460	36,709	166,421	167,630
Stoves, grates, etc.	737	944	4,962	5,924	40,450	51,949	254,992	314,765
Sanitary cisterns	233	312	1,504	1,874	7,345	9,846	47,387	61,391
Bedsteads, including tubes therefor	315	477	2,382	3,021	12,314	19,498	89,493	113,752
Hollow-ware	405	424	2,658	2,642	16,675	16,038	94,739	92,694

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

LIMPET

FOR EVERY TYPE OF CASTING

NON-FERROUS METALS

REFRACTORIES — COKE — SAND

FERRO-SILICON—FERRO-CHROME

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SITUATIONS VACANT AND WANTED

A YOUNG Foundry Engineer with unique technical training and considerable experience in cast iron metallurgy, repetition and general mould production, designing of necessary patterns, plant, etc., would like to give full particulars of his qualifications to any firm likely to require such services.—Box 494, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager wanted by The Shotts Iron Company. Applicants are thanked for their applications, and are now advised that the position has been filled.

WANTED.—Analytical Chemist (metallurgical) with wide experience in the analysis of all classes of ferrous and non-ferrous alloys. Must be accurate and quick worker. Write, giving full details of training, experience and salary required, to Box 524, BENNETT WILLIAMS, LIMITED, Dean House, Piccadilly, Bradford.

WANTED for India, Personal Assistant to General Manager. A vacancy offering exceptional prospects of rapid promotion, occurs with one of the largest Engineering Works of repute in India, engaged on general engineering work and having foundry, railway rolling stock and bridge and structural departments, for a mechanical engineer with experience of works management. Applicants should be about 38 years of age, of good general and technical education, and should have had similar experience in a well-known engineering works in Europe. Salary according to qualifications (about £115 per month) with five years agreement, free passages, provident fund and generous Home leave on renewal of contract. Apply, by letter, with copies of testimonials and details of experience stating age, and whether married or single to Box 496.—Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

DEPARTMENT OF SCIENTIFIC RESEARCH AND EXPERIMENT ADMIRALTY.

APPLICATIONS are invited for a vacant post for a Permanent Assistant III (Male) in the Admiralty Technical Pool. The place of duty in the first instance will be an Admiralty Establishment in the South of England.

2.—Every candidate must be a natural-born British subject, the child of a person who is or was at the time of death a British subject.

3.—Candidates for this post must have had a general education up to the standard of Intermediate B.Sc., and at least three years' experience in a metallurgical laboratory. They must be able to show proficiency in general metallurgical analysis work of both ferrous and non-ferrous materials, and must have had some knowledge of metallography and pyrometry.

4.—The salary scale for Assistants III is £130 x £12 - £214 (efficiency bar) x £12 - £310 per annum, but an entering salary above the minimum, although not greater than £214, may be offered to suitable candidates whose age, qualifications and experience justify it.

5.—The Assistant III posts are not pensionable on entry, but the benefits of the Superannuation Acts may be granted after some years' service to holders of permanent posts.

6.—Assistants III are eligible for promotion by merit to the grade of Assistant II, the salary scale for which is £315 x £12 - £385 per annum, and thence to Assistant I on a scale of £400 x £18 - £515 per annum, with a possible extension by annual increments of £18 to £580 per annum. For any Assistant there exists the possibility of promotion to the Officer grade in the Technical Pool.

7.—Applications, giving date of birth, particulars of qualifications and experience, and accompanied by copies of testimonials, should be forwarded to the Secretary of the Admiralty (C.E. Branch) not later than August 7, 1937, quoting Reference Number C.E. 5529/37.

8.—No application forms are required.

SITUATIONS VACANT AND WANTED.—*Contd.*

ASSISTANT Steelworks Chemist required. Stage Lab., and Gas Analysis experience essential. State age, qualifications and salary required.—WOLSINGHAM STEEL COMPANY, LIMITED, Wolsingham, Co Durham.

WANTED.—Improver Chemist. Analysis of white and grey cast iron, etc., for a Midland foundry. State age, experience, and salary required to: Box 480, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

BUSINESS FOR SALE

IRONFOUNDRY for Sale, S.E. London district, close railway. Completely equipped, nearly new plant, 3-ton overhead electrically-driven crane.—Apply RECEIVER, MORRELL, 329, High Holborn, London, W.C.1.

MACHINERY

FOR SALE.—One No. 1 "Titan" Cupolette 10-cwts. with Keith Blackman A.C. 50 cycle Blower. Only used few times.—S. C. BILSBY, Crosswells Road, Langley, near Birmingham.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO., LTD., Station Works, Ecclesfield, Sheffield.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.
30-h.p. ditto; 12-in. outlet.
5-h.p. ditto; 6-in. outlet.
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